



**HSL No. 73-11**

JUNE 15, 1973

**THIS ISSUE CONTAINS:**

HS-012 644-682; HS-012 684-704  
HS-800 532; 750-751; 766-769; 771;  
773; 780; 788-789; 791; 808  
HS-820 249; 257

**U.S. Department of  
Transportation**

National Highway  
Traffic Safety  
Administration



*Shelve in Stacks  
S.B.T.*

# Highway Safety<sup>1</sup>

73-11

## AVAILABILITY OF DOCUMENTS

Documents listed in **Highway Safety Literature** are **not** available from the National Highway Traffic Safety Administration. They must be ordered from the sources indicated on the citations, usually at cost. Ordering information for each of the sources is listed below.

**NTIS:** National Technical Information Service, Springfield, Va. 22151. **Order by title and accession number: PB, AD, or HS.**

**GPO:** Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. **Give corporate author, title, personal author, and report number.**

**Corporate author:** Contact corporate author.

**Reference copy only:** Consult your librarian.

**See serial citation:** Obtain through normal loan or purchase.

**SAE:** Society of Automotive Engineers, Dept. HSL, 2 Pennsylvania Plaza, New York, N.Y. 10001. **Order by title and SAE report numbers.**

**HRB:** Highway Research Board, National Academy of Sciences, 2101 Constitution Ave., N.W., Washington, D.C. 20418.

Material directly related to Highway and/or Motor Vehicle Safety is solicited for inclusion in Highway Safety Literature. Topics must fall within the scope of the mission of the National Highway Traffic Safety Administration. Submit material, together with a written statement of approval for publication to:

Office of Administrative Services (N48-50)  
**National Highway Traffic  
Safety Administration**  
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Entries in **Highway Safety Literature** are arranged in numerical order by HS accession number. Documents related directly to the National Highway Traffic Safety Administration (NHTSA) are numbered according to the following series: Accident Investigation Reports HS 600 000; Compliance Test Reports HS 610 000; Contractor's Reports HS 800 000; Staff speeches, papers, etc. HS 810 000; Imprints HS 820 000.

A document containing several articles is announced as complete volume under an HS number referring to it as a whole. Entries for individual articles are listed under their own HS numbers.

## SAMPLE ENTRIES

**JOURNAL ENTRY**

**Title of Document** { **SYNTHESIS OF CASE LAW JURISPRUDENCE RELATING TO WET-WEATHER HIGHWAY CONDITIONS**

**Journal Citation** → Highway Research Record n 376 p29-36 (1971)  
D. C. Oliver 1971

**Author(s)** → Sponsored by Highway Res. Board Steering Com. for Workshop on Anti-Skid Program Management and presented at the workshop.

**Search Terms** { Descriptors: \*Liability, \*Negligence, \*Accident responsibility, \*Legal responsibility, \*Wet road conditions, \*Court decisions, \*State government, \*Skidding accidents, \*Warning signs, \*Highway maintenance, \*Litigation, \*Icy road conditions,

**Abstract** { The extant case law on legal liability for accidents occurring on icy and wet highways has established three central areas and one subarea in the jurisprudence of maintenance liability. These areas are compliance with general duties in order to escape liability; damages resulting from noncompliance (negligence); contributory negligence as a bar to recovery; and advisory signing as a technique in meeting general duties. Court decisions covering these four areas are presented.

**NHTSA Accession Number** → HS-012 289  
\*Subject heading in Subject Index

**CONTRACT REPORT**

**Equipment and Procedures for Measuring Glare for Motor Vehicles. Final Report**

**Corporate author** → Teledyne Brown Engineering  
N. E. Chatterton J. D. Hayes E. W. George 1972 102p  
Contract DOT-HS-089-1-139

**Availability** → NTIS

Descriptors: \*Glare, \*Glare reduction, \*Visual perception, \*Photometers, \*Luminance, \*Hydraulic equipment, \*Central vision, \*Field of view, \*Backgrounds, \*Contrast, \*Light conditions, \*Brightness, \*Test facilities, \*Test equipment, \*Vehicle safety standards, \*Simulators, \*Light, \*Reflectance, \*Measuring instruments,

A procedure and description of equipment for measuring glare from a driver's own vehicle are presented. The procedures are based on a disability glare theory as applied to foveal vision. Two pieces of apparatus were constructed to provide the measurement capability. One of them simulates diffuse sky glare and the other simulates direct solar glare. Methods of combining data from these measurements are presented along with scaling laws selected to provide a value for glare as it would be under natural daylight conditions. A standard for allowable glare levels from the vehicle is developed which is independent of the measurement procedure. Test results from a passenger car are presented and compared with this standard. Recommendations for improvements to the apparatus and additional research requirements for improvement to the theory are made.

HS-800 731  
\*Subject heading in Subject Index

## 1. ACCIDENTS

### 1A. Emergency Services

#### THE CALL OF THE SIRENS

New York State Dept. of Health  
R. W. Nickels  
Corporate author

\*Emergency vehicle accidents, \*Ambulances, \*High speed caused accidents, \*Intersection collisions, \*Driver error caused accidents, \*Careless driving, \*Accident studies, \*Warning signals, \*Audio devices, \*Traffic laws, \*Head on collisions, \*Vehicle pedestrian collisions, \*Ejection, \*Ambulance personnel, \*Centerline crossover collisions, \*Drinking drivers, \*Traffic signal violations, \*Accident responsibility, \*Accident statistics, \*New York (State), \*State laws,

States have been urged to review both existing motor vehicle laws that relate to the operation of emergency vehicles and their enforcement. Emergency vehicles should be required to comply with all traffic laws, except in a life-and-death situation. Even then, the vehicle operator must drive with due regard for the safety of all persons. From January 1, 1969, to December 31, 1970, at least 617 ambulances were involved in vehicle accidents in New York State resulting in seven fatalities and 750 injuries. The accidents were tabulated by county and classified into four categories: intersection collisions (313); accidents where excessive speed by the ambulance driver appeared to be a major contributing factor to the accident (164); accidents where an ambulance driver appeared to be careless in the operation of his vehicle (157); other accidents such as head-on accidents, accidents where the ambulance driver was cited for being drunk, accidents involving pedestrians, accidents where the ambulance driver or passengers were ejected (75).

HS-012 658

### 1B. Injuries

#### OPTIMUM RECALL PERIOD FOR REPORTING PERSONS INJURED IN MOTOR VEHICLE ACCIDENTS

For primary bibliographic entry see Fld. 3D.  
HS-012 666

#### LETHAL EFFECTS ON MAN OF UNDERWATER DETONATION OF A FIRECRACKER

National Hwy. Traf. Safety Administration  
A. E. Hirsch, A. K. Ommaya  
Presented at the Aerospace Medical Panel Specialist Meeting  
AGARD Conference on Linear Acceleration of Impact Type,  
Oporto, Portugal, 23-26 Jun 1971.  
See serial citation

\*Underwater explosions, \*Blast injuries, \*Explosives, \*Head impact tolerances, \*Skull fractures, \*Brain injuries, \*Injury severity, \*Impact forces, \*Ear injuries, \*Accident analysis, \*Pressure responses, \*Pressure waves, \*Injury research,

A firecracker exploded in contact with the skin within six inches of the skull base of a young man swimming underwater. The resultant severe head injury and death appeared to be directly related to this underwater explosion. Reconstruction of the mechanics of this injury indicate that when the head is sub-

jected to impact energies between 440 to 1800 in-lb and impact impulse between 1.8 to 3.5 lb. sec., both skull fracture and brain injury can occur.

HS-012 688

### BIODYNAMICS OF SPORTS INJURIES

Rochester Univ., Res. Accident Investigation Team  
J. D. States

Presented at the Aerospace Medical Panel Specialist Meeting,  
AGARD Conference on Linear Acceleration of Impact Type,  
Oporto, Portugal, 23-26 Jun 1971.

See serial citation

\*Recreational accidents, \*Injury research, \*Biodynamics, \*Injury prevention, \*Automobile racing, \*Helmet design, \*Helmet standards, \*Shoulder harnesses, \*Restraint system effectiveness, \*Submarining, \*Head injuries, \*Head acceleration tolerances, \*Leg injuries, \*Leg impact tolerances, \*Skiing injuries, \*Football, \*Seat belts,

Helmets and restraint systems used in automobile racing and modified football shoe cleats and release ski bindings have reduced the injury risks in these sports. Boxing injuries do not appear controllable with safety equipment because the victor must disable his opponent usually by injuring his opponent's brain. Knowledge of human injury tolerance has been gained through the study of sports accidents particularly the determination of injury mechanisms. Conversely, injury tolerance data determined in the laboratory has been useful in designing sports safety equipment.

HS-012 689

#### STATISTICAL ANALYSIS OF SAFETY BELT USAGE IN THE STATE OF OREGON. PRELIMINARY REPORT

National Hwy. Traf. Safety Administration  
For primary bibliographic entry see Fld. 5N.  
HS-820 249

### 1C. Investigation And Records

#### AN ANALYSIS OF MOTORCYCLE ACCIDENTS WITH RECOMMENDATIONS FOR LICENSING AND OPERATION

North Carolina Univ. Hwy. Safety Res. Center  
P. F. Waller  
Corporate author

\*Motorcycle accidents, \*Vehicle motorcycle collisions, \*Accident analysis, \*Vehicle vehicle accidents, \*Single vehicle accidents, \*Accident responsibility, \*Statistical analysis, \*Motorcycle operator licensing, \*Time of accident, \*Accident rates, \*Motorcycle passengers, \*Fatality rates, \*Accident severity, \*Accident factors, \*Motorcycle visibility, \*North Carolina,

Motorcycle accidents officially reported in North Carolina in 1968 were analyzed to determine the circumstances surrounding the crashes. Altogether, 935 accident reports were examined. Two main accident categories were set up for analysis: multivehicle and single vehicle. About two-thirds of the accidents were multivehicle. In 62% of multivehicle accidents, the driver of the car was at fault. Rounding curves was the maneuver most frequently associated with single vehicle motorcycle ac-

cidents. Motorcycle passengers were present in nearly 12% of all motorcycle accidents and in almost 30% of fatal accidents. Passengers were also more likely to be present in single vehicle accidents than in multivehicle accidents. Fatalities occurred in 2.89% of all motorcycle accidents. On the basis of the analyses, recommendations are made for licensing and vehicle operation, and it is suggested that steps be taken to educate the driving public in the problems associated with sharing the highway with the motorcyclist.

HS-012 656

#### **THE CALL OF THE SIRENS**

New York State Dept. of Health  
For primary bibliographic entry see Fld. 1A.  
HS-012 658

#### **VEHICLE SIZE AND ACCIDENT INVOLVEMENT: A PRELIMINARY STUDY**

V5 N1

H. W. CaseA. BurgJ. D. Baird  
See serial citation

\*Accidents by vehicle size, \*Vehicle size, \*Driver characteristics, \*Automobile usage, \*Automobile models, \*Vehicle age, \*Driver mileage, \*Accident rates, \*Age factor in accidents, \*Accident records, \*Driver records, \*Accident risk forecasting, \*Questionnaires, \*Data acquisition, \*Data analysis, \*Sampling, \*California, \*Accidents by vehicle make, \*Accident studies,

A pilot study was conducted, using a sample of nearly 9,000 registered owners of selected subcompact, compact, and full size cars in California. This sample was obtained through responses to a mailed questionnaire, and the information collected included personal data, vehicle usage data, and accident experience of the vehicle being surveyed. Study results suggest that there is no systematic relationship between vehicle size and frequency of accident involvement, when the known effects of age and quantitative exposure to risk are controlled for. Marked differences in response rate among owners of the different vehicle makes suggest that the results must be regarded as tentative pending detailed comparison of the respondent sample with the nonrespondents for each make. An outline is proposed for a full-scale study to provide definitive information in this area.

HS-012 667

#### **A REVIEW AND CRITIQUE OF SNOWMOBILE ACCIDENT REPORTS**

For primary bibliographic entry see Fld. 1E.  
HS-012 668

#### **THE USEFULNESS OF FORMULAE IN TRAFFIC ENGINEERING AND ROAD SAFETY**

V4 N4

R. J. Smeed  
See serial citation

\*Traffic engineering, \*Accident risk forecasting, \*Fatality prediction, \*Fatality rates, \*Population density, \*Automobile population, \*Accident rates, \*Sociological factors, \*Mathematical analysis, \*Traffic flow, \*Driver behavior,

Some comments are made on a paper entitled Conceptualization and Use of Road Safety and Traffic Engineering Formulas. The author, Peranio described a good formula as one which is

applicable over a wide range of variables involved, that inaccuracies obtained from its use should be calculable, and that it should give insight into the phenomenon that it purports to describe. He suggested that when a simple formula purports to describe the phenomena of road safety or traffic engineering one can question its validity or practical usability. He then discussed several formulae used by traffic engineers in the light of these and other criteria and concluded that their use must be rejected. This paper concludes that a formula with any validity at all is almost bound to throw light on the phenomena it describes, even if it does not fully explain them, and rejects Peranio's conclusions.

HS-012 682

#### **PREDICTION OF THE NUMBER OF ROAD ACCIDENTS IN GREAT BRITAIN, 1971-1990**

V4 N4

A. L. Sweet  
See serial citation

\*Accident risk forecasting, \*Great Britain, \*Regression analysis, \*Accident analysis, \*Vehicle mileage, \*Traffic surveys, \*Traffic volume, \*Traffic counts, \*Least squares method, \*Vehicle registration, \*Commercial vehicles, \*Motorcycles, \*Motor scooters, \*Mopeds, \*Bicycles, \*Fatalities, \*Accident severity, \*Single vehicle accidents, \*Vehicle vehicle collisions, \*Multiple vehicle accidents, \*Urban highways, \*Rural highways, \*Variance analysis, \*Road Safety Act of 1967 (Great Britain), \*Time factors,

Fatal and serious accident data for the period 1961-1970, and fatal, serious, and slight accident data for the period 1965-1970, is used in a regression with vehicle mileage. The fits obtained are projected into the future. The future vehicle mileage in Great Britain, on a monthly basis, is estimated for cars and taxis, light vans, medium and heavy goods, public service vehicles, motorcycles, mopeds, and pedal cycles. Seven categories of road are considered, and one and two vehicle accidents between all seven categories of vehicle on all seven categories of road are predicted. The effect of the Road Safety Act, 1967, is taken into account.

HS-012 684

#### **MULTIDISCIPLINARY ACCIDENT INVESTIGATION REPORT AUTOMATION. VOL. 1. PROGRAM REVIEW. FINAL REPORT**

Michigan Univ., Hwy. Safety Res. Inst.  
4TH, J. C. MarshJ. O'DayHSRI-SA-72-1-1  
Contract DOT-HS-031-1-037  
Report for Feb 1971-Oct 1972. Vol. 2 is HS-800 768.  
NTIS

\*Automated accident records, \*Electronic accident analysis, \*Data banks, \*Computerized records management, \*Data processing, \*Information systems, \*Computer programs, \*Coding systems, \*Accident report forms, \*Flow charts, \*Bibliographies, \*Accident causes, \*Injury classification, \*Injury causes, \*Accident investigation, \*Multidisciplinary teams,

Over 4,500 multidisciplinary accident investigations have been conducted. These reports, sponsored by the National Highway Traffic Safety Administration (NHTSA) and the Motor Vehicle Manufacturers Association (MVMA) are edited and processed into a common data base. Both the NHTSA and MVMA

member companies are provided direct and simultaneous access to the data base through the University of Michigan's time-shared computer system via remote batch terminals and interactive terminals. The file consists of over 800 variables derived from the Collision Performance and Injury Report (CPIR) plus certain added pre-collision data. This volume discusses preparation of data for the accident data bank, file structure and contents, and data bank utilization. An annotated CPIR form, IBM 1800 Pre-build Program, an accident causation bibliography, and an occupant injury classification scheme are included.

HS-800 767

#### **MULTIDISCIPLINARY ACCIDENT INVESTIGATION REPORT AUTOMATION. VOL. 2. ANALYSIS OF MULTIDISCIPLINARY ACCIDENT INVESTIGATION DATA. FINAL REPORT**

Michigan Univ. Hwy. Safety Res. Inst.  
J. O'Day 2nd., S. Schultz HSRI-SA-72-1-2  
Contract DOT-HS-031-1-037

Report for Feb 1971-Oct 1972. Vol. 1 is HS-800 767; Vol. 3 is HS-800 769.

NTIS

\*Automated accident records, \*Electronic accident analysis, \*Statistical analysis, \*Data banks, \*Accident investigation, \*Multidisciplinary teams, \*Data processing, \*Computerized safety research techniques, \*Histograms, \*Injuries by body area, \*Injuries by age, \*Accident statistics, \*Accident factors, \*Trip purpose, \*Damage severity index, \*Chi square test,

The strengths and limitations of the Multidisciplinary Accident Investigation data in identifying traffic accident and injury problems are discussed. The data files available to users through the computer are arranged in three forms. The first file contains one case for each vehicle for which a Collision Performance and Injury Report form was completed. The second file contains one case for each occupant, with the relevant vehicle information being repeated in the cases of multiple occupancy. The third file contains one case for each injury sustained, with the relevant occupant and vehicle information being repeated as necessary. A three hour analysis study is documented to exemplify an approach to the data. The various accident investigation teams are compared in terms of date of accident, program matrix cell comments, average severity of injury and vehicle damage, occupant age and sex, and other variables. Descriptive statistics of trip origin and destination are also provided.

HS-800 768

#### **MULTIDISCIPLINARY ACCIDENT INVESTIGATION REPORT AUTOMATION. VOL. 3. MANUAL FOR SIMPLIFIED PROCEDURES FOR ANALYSIS OF DATA. FINAL REPORT**

Michigan Univ. Hwy. Safety Res. Inst.  
HSRI-SA-72-1-3

Contract DOT-HS-031-1-037

Report for Feb 1971-Oct 1972. Supported in part by Motor Vehicle Manufacturers Assoc. Vol. 2 is HS-800 768.

NTIS

\*Automated accident records, \*Electronic accident analysis, \*Computer operators manuals, \*Data banks, \*Information retrieval, \*Computer programs, \*Data processing, \*Statistical

analysis, \*Data analysis, \*Real time operations, \*Time sharing, \*Histograms, \*Variance analysis, \*Computer printouts, \*Multivariate analysis,

Access to data stored in the accident data banks at the Highway Safety Research Institute is considerably simplified through use of the Simplified Procedures for Analysis of Data (SPAD) system. This computer allows users who have minimal knowledge in the operation of time shared computer terminals to query the data banks for answers to many accident related questions. This manual provides the necessary background for operating the Michigan Terminal System from a remote terminal; for understanding the basic structure and contents of the accident files and analysis tools; and for using the SPAD system to obtain the desired analysis results.

HS-800 769

#### **MULTIDISCIPLINARY ACCIDENT INVESTIGATION REPORT AUTOMATION. VOL. 5. EDITING MANUAL AND REFERENCE INFORMATION. FINAL REPORT**

Michigan Univ. Hwy. Safety Res. Inst.  
4TH, J. C. Marsh S. O. Vanek HSRI-SA-72-1-5  
Contract DOT-HS-031-1-037

Report for Feb 1971-Oct 1972. Vol. 3 is HS-769.

NTIS

\*Automated accident records, \*Data processing, \*Data banks, \*Instruction manuals, \*Coding systems, \*Punched cards, \*Accident report forms, \*Computerized records management, \*Vehicle characteristics, \*Automobile dimensions, \*Injury severity index, \*Automobile models, \*Restraint systems, \*Seat backs, \*Steering wheels, \*Windshields, \*Quality control, \*Damage severity, \*Multidisciplinary teams, \*Accident investigation,

Traffic accident data reported on the General Motors Collision Performance and Injury Report (CPIR) Long Form revision 3 plus certain supplementary information are edited and maintained as an on-line computer file in the Highway Safety Research Institute accident data bank. A compilation of reference information and editing conventions used in preparing newly received reports for inclusion in the computer data bank are presented. This manual is the basic reference and instructional document used in daily operations and in the training of new case editors and it may also be usefully employed by accident investigators preparing CPIR forms and data analysis using the CPIR computer files.

HS-800 771

#### **VSDSS RESEARCH STUDIES. FINAL REPORT**

New York State Dept. of Motor Vehicles  
For primary bibliographic entry see Fld. 5D.  
HS-800 780

### **2. HIGHWAY SAFETY**

#### **2B. Communications**

#### **VEHICULAR COMMUNICATIONS RESEARCH. FINAL REPORT**

GTE-Sylvania Inc.  
R. F. Wright C. G. Roberts H. Hochman FHWA-RD-72-11; PB-20  
Contract FH-11-7581  
NTIS

## Group 2B—Communications

\*Communication systems, \*Antennas, \*Highway communication, \*Performance tests, \*Vehicle detectors, \*Driver aid systems, \*Frequencies, \*Transmission bands, \*Radios, \*Mathematical analysis, \*Polarization, \*Acoustic measurement, \*Sound intensity, \*Linear systems, \*Impedance, \*Wire, \*Electric fields, \*Concretes, \*Asphalt pavements, \*Pavement tests, \*Test equipment, \*Measuring instruments, \*Water effects, \*Degradation failures, \*Dipole antennas,

This project involved theoretical analysis design, fabrication, and evaluation testing of highway communication systems using buried antennas. Point and linear communication systems are included and development of both roadway and vehicle antenna systems was required. Also included was an investigation of the capability of buried antennas to perform a vehicle detection role. Results indicated that buried antennas, particularly VHF and UHF dipoles, are feasible for use in a highway communication system. Recommendations are made for implementing such a system.

HS-012 651

## A MOTORIST RADIO SERVICE. FINAL REPORT

Advanced Technology Systems, Inc.  
J. J. Renner A. D. Owen FHWA-RD-72-16; ADVAT  
Contract FH-11-7742  
NTIS

\*Communication systems, \*Highway communication, \*Radio communication, \*Driver to driver communications, \*Emergency reporting systems, \*Warning systems, \*Frequencies, \*Frequency modulation, \*Costs, \*Reviews,

The objective of this project was to establish the basis for the promulgation of Federal Communications Commission Rules and Regulations governing a Motorist Radio Service. Such service was to provide a motorist the means for immediately obtaining information pertinent to driving conditions and for obtaining assistance from other motorists or from organizations that provide highway services. It would also provide a means for no-delay reporting of information between motorist and highway authorities for transmission of automatic road hazard warnings, and for automatic location of a communicating vehicle. This service would thus provide for rapid detection and automatic location of vehicle emergencies. It is recommended that a 2.4 MHz of spectrum in two 1.2 MHz blocks separated by at least 20 MHz be provided between 100 MHz and 500 MHz for development of a motorist communication system. The characteristics of the system are described in detail.

HS-012 654

## 2D. Design And Construction

## A HANDBOOK OF HIGHWAY SAFETY DESIGN AND OPERATING PRACTICES, REV. ED.

Federal Hwy. Administration

GPO \$2.00

\*Highway design, \*Safety design, \*Manuals, \*Highway improvements, \*Bridge design, \*Sign design, \*Sign location, \*Barrier design, \*Culverts, \*Drainage, \*Railroad grade crossings, \*Exits, \*Lighting design, \*Gores, \*Antiskid materials, \*Pavement skid resistance, \*Lane drops, \*Energy absorbing barriers, \*Road shoulders, \*Slopes, \*Guardrails, \*Median barriers, \*Sign

supports, \*Bridge parapets, \*Urban lighting, \*High level lighting, \*Impact attenuators, \*Breakaway structures, \*Highway lighting,

This handbook will be useful in selecting the best corrective treatment for locations which are hazardous or which have operational problems. Current practices and problems in the areas of cross sections and slopes; bridge design; sign design, location, and supports; guardrail, median, and energy absorbing barrier design; drainage; railroad grade crossings; gores; lighting design, high level, and urban lighting; skid prevention; and lane drops are discussed and illustrated. A categorized list of terms covered or which may be covered in supplements or future editions of the handbook is included.

HS-012 644

## TEST AND EVALUATION OF VEHICLE ARRESTING, ENERGY ABSORBING, AND IMPACT ATTENUATION SYSTEMS. FINAL REPORT

Texas A and M Univ. Texas Transp. Inst.  
T. J. Hirsch D. L. Ivey PB-207 840  
Contract CPR-11-5851  
NTIS

\*Crash cushions, \*Energy absorbing barriers, \*Barrier collision tests, \*Impact attenuation, \*Energy absorption, \*Guardrail impact tests, \*Barrier design, \*Guardrail design, \*Median barrier design, \*Kinetic energy, \*Vehicle center of gravity, \*Impact forces, \*Impact angle, \*Human body impact tolerances, \*Human acceleration tolerances, \*Human deceleration tolerances, \*Energy absorbing materials, \*Deceleration, \*Reviews, \*Test facilities, \*Remote controlled automobiles, \*Test equipment, \*Photographic equipment, \*High speed photography, \*Data analysis, \*Telemetry, \*Transducers, \*Impact attenuators, \*Rebound,

Full scale vehicle crash tests were conducted to evaluate a variety of vehicle arresting, redirecting, energy absorbing, and impact attenuation systems. In addition, research work was done to establish the feasibility of using steel drums, lightweight cellular concrete, corrugated metal pipe, and concrete pipe as energy absorbing materials for such vehicle impact attenuation systems. Descriptions of the systems evaluated and test summaries are presented. A literature survey on human tolerance criteria is included. Several of these vehicle impact attenuation systems developed or tested and evaluated on the project have been successfully implemented on the nation's highways.

HS-012 652

## THE VISIBILITY AND AUDIBILITY OF TRAINS APPROACHING RAIL-HIGHWAY GRADE CROSSINGS. FINAL REPORT

Systems Consultants, Inc.  
J. P. Aurelius N. Korobow FRA-RP-71-2; PB-202  
Contract DOT-FR-00006  
NTIS

\*Vehicle visibility, \*Railroads, \*Flashing warning signals, \*Audio warning devices, \*Warning system effectiveness, \*Vehicle lighting, \*Acoustic measurement, \*Sound intensity, \*Auditory perception, \*Visual perception, \*Brightness, \*Fluorescent colors, \*Contrast, \*Headlamps, \*Swiveling headlamps, \*Night

visibility, \*Mathematical analysis, \*Graphic techniques, \*Railroad grade crossing accidents, \*Accident statistics, \*Variance analysis, \*Scale models, \*Computer programs, \*Frequencies, \*Horns,

This study investigates devices and color schemes, proposed or in use on locomotives, which serve to make the train visible or audible to motorists approaching grade crossings. A color scheme using two contrasting colors, each color at least 3 1/2 by 5 feet in area, is recommended for visibility at 1,000 feet. One color should be very bright, such as fluorescent or bright yellow. Two high-output xenon strobe lamps are recommended, one on each side of the cab roof, to flash alternately whenever the train is moving. At night, lighted panels are recommended as supplements to the strobe lamps. The sound level required to reliably alert a motorist was found to be 105 dB just outside the vehicle. In high speed encounters, present horns cannot reliably warn motorists early enough. A horn with enough output to be totally effective would be an unacceptable nuisance. A bibliography and tables of required ranges are included.

HS-012 660

## **2G. Meteorological Conditions**

### **TRANSPORTATION NOISE AND ITS CONTROL**

Department of Transp.  
DOT-P5630.1  
GPO \$0.70

\*Transportation noise, \*Noise control, \*Noise sources, \*Aircraft noise, \*Traffic noise, \*Vehicle noise, \*Acoustic measurement, \*Noise standards, \*Engine noise, \*Motorcycles, \*Truck trailers, \*High powered automobiles, \*Sound intensity, \*Sound dissipation, \*Sound absorbing materials, \*Rapid transit systems, \*Tire noise, \*Residential location, \*Mathematical analysis, \*Federal role, \*State government, \*Local government,

Specific aspects of the noise problem caused by subsonic and supersonic aircraft, highway vehicles, and rapid transit are outlined. Noise abatement techniques which have been studied and/or applied are highlighted. The appendices cover technical aspects of the noise problem including measurement of noise, propagation of sound in the atmosphere, and residential noise level guidelines.

HS-012 659

### **EUROPE SEEKS COMMON SOLUTIONS TO PROBLEMS OF EMISSIONS AND NOISE**

For primary bibliographic entry see Fld. 5F.  
HS-012 674

### **NATIONWIDE PERSONAL TRANSPORTATION SURVEY. REPORT 3. SEASONAL VARIATIONS OF AUTOMOBILE TRIPS AND TRAVEL**

Federal Hwy. Administration  
H. E. Strate  
Rept. 2 is HS-012 691; rept. 4 is HS-012 693.  
Corporate author

\*Automobile usage, \*Travel patterns, \*Vehicle mileage, \*Driver residence, \*Trip purpose, \*Trip length, \*Day of week, \*Spring, \*Summer, \*Winter, \*Fall, \*Trip frequencies, \*Surveys, \*Questionnaires,

Seasonal patterns of automobile trips and vehicle mileage were examined within four selected parameters: place of residence by unincorporated areas and incorporated places; trip purpose; trip length; and day of the week. It was found that more trips are taken in the spring; a greater percentage of vehicle miles are driven during the summer; the percentage of vehicle miles traveled is lowest during the winter; the average automobile trip length is longer in summer; excluding educational, work, and religious trips the largest seasonal effect on vehicle trips is in the social and recreational trip purpose categories; trips for family and business purposes show no significant seasonal variation in average trip length; in each season, approximately 30% of trips taken are in the one and two mile classes; and the average automobile trip length is 8.9 miles per trip for all seasons combined, and ranges from a low of 8.3 miles a day in the winter to a high of 10.1 miles a day in the summer.

HS-012 692

### **LAWS AND REGULATORY SCHEMES FOR NOISE ABATEMENT**

George Washington Univ.  
For primary bibliographic entry see Fld. 4A.  
HS-012 694

## **2I. Traffic Control**

### **AN INVESTIGATION OF THE CAR-FOLLOWING MODEL USING CONTINUOUS SYSTEM MODEL PROGRAM (CSMP) TECHNIQUES. FINAL REPORT**

Pennsylvania Univ.  
L. EisenbergE. KaplanUMTA-URT-8 (70)-71-04  
Contract DOT-UT-253  
Sponsored by Urban Mass Transp. Administration. Appendix B is IBM System/360 Continuous System Modeling Program (360A-CX-16X) Application Description.  
NTIS

\*Car following, \*Continuous flow models, \*traffic simulation, \*Mathematical models, \*Computer programs, \*Traffic flow, \*Vehicle stability, \*Vehicle dynamics, \*Feedback control, \*Computerized simulation, \*Driver vehicle road interfaces, \*Highway characteristics, \*Driver characteristics, \*Perception, \*Systems analysis, \*Linear systems, \*Nonlinear systems, \*Vehicle spacing, \*Algorithms, \*Transformations, \*Distance headways, \*Velocity, \*Computer operators manuals, \*Fortran, \*Equations of motion, \*Tracking,

This report discusses general aspects of traffic theory, feedback control theory, stability analysis, and utilization of the Continuous System Modeling Program (CSMP) to solve the dynamic equations of single- and multiple-sense, linear and non-linear car-following models.

HS-012 653

### **PROBLEMS IN THE RATIONAL ANALYSIS OF TRANSPORTATION SAFETY**

V4N4  
G. Raisbeck  
Contract FA70WA-2141  
See serial citation

\*Accident risk forecasting, \*Risk taking, \*Benefit cost analysis, \*Traffic control, \*Traffic capacity, \*Aircraft safety, \*Liability,



Analysis of air traffic control capacity shows the relation between traffic level and risk can be dealt with quantitatively only if units of risk are specified. Measuring risk in terms of fatalities per hour of exposure solves the major problem of how to compare the effects that many different kinds of risk have upon patterns of human activity, but leaves the following secondary issues unresolved: incommensurability of certain risks, failure of statistical independence, certain limitations of time-normalization, unequal distribution of costs and benefits, different weighting of voluntary and involuntary risks, liability, cost and value of uncertainty, positive value of some risks, acceptability of unequal risks, difficulty of estimating very small probabilities, and threat of the unknown compared to threat of the known. Although these issues arose from air traffic control studies, they are clearly relevant to risk analyses of many other systems.

HS-012 681

### 3. HUMAN FACTORS

#### 3A. Alcohol

##### HOW MUCH IS TOO MUCH? A STUDY OF PROBLEM CONSUMPTION AS RELATED TO ALCOHOL AND HIGHWAY SAFETY

Highway Safety Foundation

Corporate author

\*Alcohol usage, \*Drinking drivers, \*Blood alcohol levels, \*Alcohol effects, \*Breathalyzers, \*Alcohol breath tests, \*Interviews, \*Driver intoxication, \*Driver records, \*Law enforcement, \*Alcohol education, \*Mass media, \*Alcohol laws, \*Alcoholic beverages, \*Ohio, \*Arrests, \*Nomographs, \*Body weight, \*Mansfield (Ohio),

Interviews conducted in Mansfield, Ohio, with drinkers in the population at large, drivers with at least one conviction for driving while intoxicated, and drinkers in a party situation, indicate that drinkers do not know when they have consumed enough drinks to raise their blood alcohol level to 0.1% (the level of intoxication in Ohio). Interviews with bartenders and results of an experiment in which a Highway Safety Research staff member, accompanied by two observers was sent to a bar to determine how many drinks he could obtain before his service would be terminated by the bartender, show that the retailer has no more knowledge concerning potential abuse of alcohol than does the consumer and apparently is not concerned with problem consumption. The effectiveness of alcohol education and methods of alcohol law enforcement are discussed.

HS-012 686

#### 3C. Cyclists

##### AN ANALYSIS OF MOTORCYCLE ACCIDENTS WITH RECOMMENDATIONS FOR LICENSING AND OPERATION

North Carolina Univ. Hwy. Safety Res. Center  
For primary bibliographic entry see Fld. 1C.  
HS-012 656

#### MOTORCYCLES

For primary bibliographic entry see Fld. 5C.

HS-012 664

### 3D. Driver Behavior

##### PROFILE OF THE AGING DRIVER. WHO HE IS, WHEN, WHERE, HOW HE DRIVES

V73 N1

T. W. Planek R. B. Overend

See serial citation

\*Aged drivers, \*Age factor in driving, \*Age factor in accidents, \*Male drivers, \*Female drivers, \*Driver mileage, \*Accident risks, \*Accident rates, \*Accident severity, \*Driver records,

Several studies on the aged driver are briefly reviewed. Studies have shown that drivers in their 50's begin to show a decrease in annual miles driven that continues steadily in later years. This decrease in mileage found among older drivers is mainly in what might be called difficult driving, which would include rush hour driving, daily driving, driving after dark, and winter driving. Although drivers over 64 are responsible in more two-vehicle accidents, based on mileage, than any other age group, the aging driver, in comparison with the younger driver, has accidents that are less serious by type, less frequent at above-average speeds, and less connected with alcoholic intoxication.

HS-012 662

##### OPTIMUM RECALL PERIOD FOR REPORTING PERSONS INJURED IN MOTOR VEHICLE ACCIDENTS

V5 N1

W. S. Cash A. J. Moss

Condensation of a report available from GPO as Vital and Health Statistics-Series 2-No. 50.  
See serial citation

\*Statistical analysis, \*Injury statistics, \*Memory, \*Reliability, \*Data analysis, \*Data acquisition, \*Accident reports, \*Injury severity, \*Time factors, \*Questionnaires, \*North Carolina,

A study was carried out in 1967 and 1968 to determine the best length of recall period to use in a survey for estimating the annual incidence of motor vehicle injuries. A special supplement to the Health Interview Survey questionnaire was administered to persons in a three county area of North Carolina who were known from data on official accident report forms to have been involved, and usually injured, in a motor vehicle accident. Comparison of answers received in the survey with data from the official report forms revealed the accuracy of respondents answers as to whether or not they had been injured and the length of time since the accident had occurred. These data were analyzed in terms of length of recall period, classification of injury, and type of respondent (proxy or self). The technique used to determine the optimum recall period was the analysis of the relative root mean square error. The results of this study indicated that three months was the optimum recall period for the reporting of motor vehicle injuries and selected characteristics of the accident.

HS-012 666

##### VEHICLE SIZE AND ACCIDENT INVOLVEMENT: A PRELIMINARY STUDY

For primary bibliographic entry see Fld. 1C.  
HS-012 667

# THE MEASUREMENT OF DRIVER DESCRIBING FUNCTIONS IN SIMULATED STEERING CONTROL TASKS

Systems Technology, Inc.  
For primary bibliographic entry see Fld. 5R.  
HS-012 669

# ESTIMATION OF AUTOMOBILE-DRIVER DESCRIBING FUNCTIONS FROM HIGHWAY TESTS USING THE DOUBLE STEERING WHEEL

California Univ., Berkeley  
P. DelpE. R. F. W. CrossmanH. Szostak  
Presented at meeting held at University of Southern California, Los Angeles, 2-4 Jun 1971.  
NTIS in N73-10104

\*Vehicle control, \*Driving task analysis, \*Steering, \*Driver performance, \*Driver modeling, \*Instrumented vehicles, \*Servomechanisms, \*Test equipment, \*Driver emergency responses, \*Driver monitoring, \*Driver reaction time, \*Data analysis, \*Frequencies, \*Lateral force, \*Vehicle dynamics, \*Steering force, \*Tracking, \*Torque, \*Road tests, \*Lateral acceleration,

The automobile-driver describing function for lateral position control was estimated for three subjects from frequency response analysis of straight road test results. The measurement procedure employed an instrumented full size sedan with known steering response characteristics, and equipped with a lateral lane position measuring device. Forcing functions were inserted through a servo driven double steering wheel. Random appearing, Gaussian, and transient time functions were used. The quasi-linear models fitted to the random appearing input frequency response characterized the driver as compensating for lateral position error in a proportional, derivative, and integral manner. A fourth term corresponding to response to lateral acceleration was determined by matching the time response histories of the model to the experimental results. This model parameter also accounted for the driver's direct response to steering wheel reaction torques. The time histories show evidence of pulse-like nonlinear behavior during extended response to step transients which appear as high frequency remnant power.

HS-012 670

# SOME INTERACTIONS AMONG DRIVER, VEHICLE, AND ROADWAY VARIABLES IN NORMAL DRIVING

Wright State Univ.  
M. L. RitchieJ. M. HowardW. D. Myers  
Presented at meeting held at University of Southern California, Los Angeles, 2-4 Jun 1971.  
NTIS in N73-10104

\*Driver vehicle road interfaces, \*Driver performance, \*Lateral acceleration, \*Velocity, \*Road curves, \*Ohio, \*Male drivers, \*Female drivers, \*Driver handedness, \*Buicks, \*Station wagons, \*Day vs night performance, \*Day vs night speeds, \*Tire inflation pressure, \*Road curve signs, \*Speed signs, \*Sign effectiveness, \*Speedometer effect on control, \*Road tests, \*Gravitation, \*Driver mileage, \*Design of experiments, \*Right turns, \*Left turns,

Sixty subjects were run in a 1962 Buick Invicta station wagon with power steering and brakes, on a 110 mile course over Ohio

state highways. Fifteen subjects were run with the tire pressure lowered to 21 lb cold (from the standard 29). Another 15 were run with the speedometer covered. Fifteen more subjects were run at night, and 15 acted as a control group. The group with low tires and the group with no speedometer drive faster than the control group. The night group did not drive faster than the control but produced lower lateral accelerations than the other groups. Effects of the presence of speed signs, curve signs, and direction of turn on choice of speed in curves, and actual speed in curves relative to advisory sign speeds are plotted.

HS-012 671

## 3F. Driver Licensing

### DRIVERS' RECORDS: ARE THEY A VALID MEASURE OF DRIVING BEHAVIOR?

V4  
R. Zylman  
Personal author

Drivers' records are used as a basis for administering point systems, for evaluating credit applications, for setting insurance rates, and as a source of information for research studies. The keystone to the justification of these activities is in the uniformity, consistency, and completeness of: collision investigation and reporting; and the enforcement, prosecution, and adjudication and subsequent reporting of traffic law violations to the Department of Motor Vehicles. These activities and records are neither uniform, consistent, nor complete. It must be recognized that police agencies, prosecutors, and judges enjoy relative autonomy. Each may use his own interpretations, his own definitions, and his own terminology which, in turn, are designed to fit his own policies and practices. As a result, whether one is judged to be a better or worse than average driver may be more a reflection of the policies, practices, and attitudes of the controlling agents, and agencies in the community than a description of behavior.<sup>13</sup>Driver records; Data acquisition; Driver evaluation devices; Driver behavior; Data uniformity; Accident reports; Accident reporting laws; Traffic law enforcement; Police reports; Unreported accidents; Local government; Political factors; Accident risks; California; New York (State); Accident rates; Reliability; Multidisciplinary teams

HS-012 679

### MOBILE DRIVER LICENCE TESTING UNIT. A DEMONSTRATION PROJECT. FINAL REPORT

Colorado Dept. of Revenue

Contract FH-11-7108  
Includes Mobile Driver Improvement and License Testing Unit.  
NTIS

\*Driver licensing, \*Driver license examination, \*Test facilities, \*Demonstration projects, \*Colorado, \*Benefit cost analysis, \*Rural areas, \*Consumer acceptance, \*Test equipment, \*Mobile homes, \*Driver evaluation devices, \*Computerized driver testing, \*Driver education, \*Program evaluation, \*Vehicle operating costs, \*State Motor Vehicle Departments, \*Questionnaires, \*Mobile driver license testing unit,

A mobile driver license testing unit was developed from a converted mobile home to provide service to rural areas of Colorado. The unit houses automated testing facilities with the

## Group 3F—Driver Licensing

ability to immediately respond to an answered question. Questions, and illustrations, used in the van's test equipment were designed and directed toward learning as well as testing. Public acceptance, determined by a questionnaire, was favorable. The major deficiency of the mobile unit was its high initial cost. Costs can be reduced by fitting such units to meet demonstrated needs and reducing the number of operating personnel. Benefits and cost of the unit, the driving test, operation and design of the unit, and hardware are analyzed. A copy of the demonstration project contract and its modifications, the public opinion questionnaire, test questions, the paper tape printout of the unit's automated equipment, and personnel job descriptions are included.

HS-800 532

## 3H. Environmental Effects

## PEDESTRIAN ZONE IN MUNICH: MOTIVATION FOR PEDESTRIAN MOVEMENT

For primary bibliographic entry see Fld. 3K.  
HS-012 647

## 3K. Pedestrians

## PEDESTRIAN ZONE IN MUNICH: MOTIVATION FOR PEDESTRIAN MOVEMENT

V43 N2  
S. Teply  
See serial citation

\*Malls, \*Safety zones, \*Pedestrian safety, \*Munich, \*Central business districts, \*Automobile bans, \*Pedestrian density, \*Subways, \*Parking garages, \*Traffic management, \*Landscaping, \*Underpasses, \*Acoustic measurement, \*Noise, \*Air pollution measurement, \*Traffic engineering, \*Pedestrian dynamics, \*Speed volume relationships, \*Speed studies, \*Environmental planning, \*Urban lighting, \*Pavements,

Difficulties with vehicular and streetcar traffic in Munich's city center led to development of a pedestrian zone. Its construction was combined with the construction of underground railways. The pedestrian zone became a new motivation for pedestrian movement. Its atmosphere was evolved using technical and architectural features, such as transportation facilities, traffic management in surrounding streets, parking, functional division of the area, artistic and flower decoration, lighting, fountains, pavement, restaurants and kiosks. Two types of measurements were undertaken. The first showed that the two different motivation groups - work, business and shopping on one hand and entertainment on the other hand - are reflected in speed of pedestrian movement. The second environmental measurement, illustrates that pedestrian zones in the city center can improve only locally caused air pollution and noise condition difficulties, but the general pollution level depends on conditions in the whole city center.

HS-012 647

## 4. OTHER SAFETY-RELATED AREAS

## 4A. Codes And Laws

## A STUDY OF HAZARDOUS MATERIALS INFORMATION NEEDS AND IDENTIFICATION

## SYSTEMS FOR TRANSPORTATION PURPOSES. FINAL REPORT

Northwestern Univ.

G. J. Rath A. M. Bottoms D. Hagerty D. Morin W. H. Money TSA-20-72-4; DDC-72-Contract DOT-OS-10042  
NTIS

\*Hazardous materials, \*Transportation of hazardous materials, \*Information systems, \*Labeling, \*Regulations, \*Identification, \*Packaging, \*Warning systems, \*Warning signs, \*Visual coding, \*Sign visibility, \*Sign legibility, \*Reflectorized signs, \*Sign design, \*Human factors engineering, \*Manpower utilization, \*Reviews, \*Bibliographies,

Information needs and methods to transmit that information are analyzed to determine the basic requirements of a hazard identification system for packages containing, and vehicles carrying, hazardous materials. Persons who come in contact with hazardous materials shipments are identified and a typology developed. Information needs (type, amount, and timing) are listed by category, and 16 existing labeling systems are evaluated according to these and human factors criteria. Another dimension of users considered is transportation mode (air, rail, trucks), and job function (regulators, supervisors) generating personnel categories. Conclusions and recommendations based on this analysis are discussed.

HS-012 663

## THE COST EFFECTIVENESS OF INTERNATIONAL VEHICLE REGULATIONS

V81 N3  
W. Stork  
See serial citation

\*Benefit cost analysis, \*Safety economics, \*Safety standards costs, \*Automobile costs, \*Vehicle safety standards, \*Restraint system effectiveness, \*Lead time, \*Accident statistics, \*Consumer acceptance, \*International compacts, \*Europe, \*Safety device costs,

Additional manufacturing costs, lead time, consumer acceptance, and accident data are factors which should be considered in determining the cost effectiveness of international vehicle regulations. Certification procedures, type approval, and documentation required by vehicle standards increase automobile costs but do not contribute directly to the benefits of a safety program. The benefits resulting from a fast introduction of safety standards have to be weighed against the disadvantages of the increased cost of short lead times. Consumer attitude should also be considered. For the European market, it has been estimated that only 5% cost increases per year on cars will be accepted by the public. Higher cost increases reduce the number of new cars sold and slow down the market penetration of new safety measures. It is concluded that European countries should build better roads before making cars more expensive, perhaps with the exception of installation of seat belts and head rests on the front seats.

HS-012 675

## LAWS AND REGULATORY SCHEMES FOR NOISE ABATEMENT

George Washington Univ.  
PB-206 719

June 15, 1973

## OTHER SAFETY-RELATED AREAS—Field 4

### Mathematical Sciences—Group 4G

Contract EPA-68-04=0032  
NTIS

\*Noise control, \*Noise standards, \*Federal laws, \*State laws, \*Local government, \*Court decisions, \*Regulations, \*Aircraft noise, \*Transportation noise, \*Vehicle noise, \*Industrial noise, \*Construction sites, \*Acoustic measurement, \*Sound intensity, \*Law enforcement, \*Program evaluation, \*Sociological factors, \*Noise sources, \*Noise tolerances, \*Legal factors, \*State action, \*Federal control, \*Federal state relationships, \*Acoustics, \*Traffic noise, \*California, \*Colorado, \*Florida, \*Hawaii, \*Illinois, \*New York (State), \*North Dakota, \*Pennsylvania, \*Minnesota,

The existing federal, state, and local laws, ordinances, and regulations governing the abatement and control of environmental noise are reviewed and their effectiveness evaluated. Relevant court cases are also surveyed. Among the more significant findings and conclusions are the following: the existing environmental noise regulatory structure is fragmented in organization and ad hoc in operation; regulation by the Federal government has been slight; regulation by the states has for the most part been limited to selected noise sources; most noise abatement regulation has taken place at the local level by means of general noise ordinances or ordinances directed to specific noise sources both state and local governmental levels are handicapped in police power regulation of some of the more critical noise sources; very little attention has been given to construction site noise, or to domestic noise sources; and enforcement of noise abatement state statutes and municipal noise ordinances has been notoriously spasmodic and uniformly weak. Problems in the regulation and abatement of noise are identified and discussed and some solutions are proposed.  
HS-012 694

#### 4B. Community Support

##### A STUDY OF EFFECTIVENESS OF A RADIO/TV CAMPAIGN ON SAFETY BELT USE

For primary bibliographic entry see Fld. 5N.  
HS-012 665

#### 4C. Cost Effectiveness

##### TRAFFIC ACCIDENT COSTS IN ECONOMIC ANALYSIS

Highway Users Federation for Safety and Mobility  
R. WinfreyTech-Study-M-3  
Corporate author

\*Accident costs, \*Economic analysis, \*Pricing, \*Damage costs, \*Injury costs, \*Time costs, \*Life value, \*Medical costs, \*Value analysis,

Traffic accident costs as input data for economic analysis of alternatives proposed to improve highway safety and mobility are examined. Pricing procedures for the measurable elements of property damage, personal injury, and fatal injury costs are discussed. The input data should include cost items for the loss of work-time due to temporary and permanent disabling injuries and for net costs for the loss of life in fatal accidents. For consistency, these three lost time situations should have the same, or at least related, methods of measure. Lost productivity measured by the value of lost-work time offers a convenient, quantifiable, common measure for these inputs.  
HS-012 661

##### EUROPE SEEKS COMMON SOLUTIONS TO PROBLEMS OF EMISSIONS AND NOISE

For primary bibliographic entry see Fld. 5F.  
HS-012 674

##### THE COST EFFECTIVENESS OF INTERNATIONAL VEHICLE REGULATIONS

For primary bibliographic entry see Fld. 4A.  
HS-012 675

##### PROBLEMS IN THE RATIONAL ANALYSIS OF TRANSPORTATION SAFETY

For primary bibliographic entry see Fld. 2I.  
HS-012 681

##### COMPONENT DEGRADATION: BRAKE SYSTEM PERFORMANCE. VOL. 2. FINAL TECHNICAL REPORT

Bendix Corp.  
For primary bibliographic entry see Fld. 5A.  
HS-800 751

#### 4E. Information Technology

##### MULTIDISCIPLINARY ACCIDENT INVESTIGATION REPORT AUTOMATION. VOL. 1. PROGRAM REVIEW. FINAL REPORT

Michigan Univ., Hwy. Safety Res. Inst.  
For primary bibliographic entry see Fld. 1C.  
HS-800 767

##### MULTIDISCIPLINARY ACCIDENT INVESTIGATION REPORT AUTOMATION. VOL. 2. ANALYSIS OF MULTIDISCIPLINARY ACCIDENT INVESTIGATION DATA. FINAL REPORT

Michigan Univ. Hwy. Safety Res. Inst.  
For primary bibliographic entry see Fld. 1C.  
HS-800 768

##### MULTIDISCIPLINARY ACCIDENT INVESTIGATION REPORT AUTOMATION. VOL. 3. MANUAL FOR SIMPLIFIED PROCEDURES FOR ANALYSIS OF DATA. FINAL REPORT

Michigan Univ. Hwy. Safety Res. Inst.  
For primary bibliographic entry see Fld. 1C.  
HS-800 769

##### MULTIDISCIPLINARY ACCIDENT INVESTIGATION REPORT AUTOMATION. VOL. 5. EDITING MANUAL AND REFERENCE INFORMATION. FINAL REPORT

Michigan Univ. Hwy. Safety Res. Inst.  
For primary bibliographic entry see Fld. 1C.  
HS-800 771

#### 4G. Mathematical Sciences

##### VEHICULAR COMMUNICATIONS RESEARCH. FINAL REPORT

GTE-Sylvania Inc.  
For primary bibliographic entry see Fld. 2B.  
HS-012 651

## Field 4—OTHER SAFETY-RELATED AREAS

HSL 73, No. 11

### Group 4G—Mathematical Sciences

#### AN INVESTIGATION OF THE CAR-FOLLOWING MODEL USING CONTINUOUS SYSTEM MODEL PROGRAM (CSMP) TECHNIQUES. FINAL REPORT

Pennsylvania Univ.

For primary bibliographic entry see Fld. 2I.

HS-012 653

#### OPTIMUM RECALL PERIOD FOR REPORTING PERSONS INJURED IN MOTOR VEHICLE ACCIDENTS

For primary bibliographic entry see Fld. 3D.

HS-012 666

#### THE MEASUREMENT OF DRIVER DESCRIBING FUNCTIONS IN SIMULATED STEERING CONTROL TASKS

Systems Technology, Inc.

For primary bibliographic entry see Fld. 5R.

HS-012 669

#### ESTIMATION OF AUTOMOBILE-DRIVER DESCRIBING FUNCTIONS FROM HIGHWAY TESTS USING THE DOUBLE STEERING WHEEL

California Univ., Berkeley

For primary bibliographic entry see Fld. 3D.

HS-012 670

#### SOME INTERACTIONS AMONG DRIVER, VEHICLE, AND ROADWAY VARIABLES IN NORMAL DRIVING

Wright State Univ.

For primary bibliographic entry see Fld. 3D.

HS-012 671

#### THE USEFULNESS OF FORMULAE IN TRAFFIC ENGINEERING AND ROAD SAFETY

For primary bibliographic entry see Fld. 1C.

HS-012 682

#### PREDICTION OF THE NUMBER OF ROAD ACCIDENTS IN GREAT BRITAIN, 1971-1990

For primary bibliographic entry see Fld. 1C.

HS-012 684

#### PRINCIPLES OF TIRE DESIGN

For primary bibliographic entry see Fld. 5V.

HS-012 697

#### LABORATORY TIRE TREADWEAR TESTING

For primary bibliographic entry see Fld. 5V.

HS-012 700

#### TIRE STRESS AND DEFORMATION FROM COMPOSITE THEORY

For primary bibliographic entry see Fld. 5V.

HS-012 702

#### MATHEMATICAL PREDICTION OF DYNAMIC TIRE BEHAVIOR

For primary bibliographic entry see Fld. 5V.

HS-012 703

#### FORMATION OF HYDROCARBONS AND OXIDES OF NITROGEN IN AUTOMOBILE ENGINES

For primary bibliographic entry see Fld. 5F.

HS-012 704

#### COMPUTER SIMULATION OF VEHICLE HANDLING, VOL. 1--FINAL SUMMARY REPORT

Bendix Corp.

For primary bibliographic entry see Fld. 5R.

HS-800 788

#### COMPUTER SIMULATION OF VEHICLE HANDLING. FINAL REPORT

Bendix Corp.

For primary bibliographic entry see Fld. 5R.

HS-800 789

### 4H. Transportation Systems

#### NATIONWIDE PERSONAL TRANSPORTATION SURVEY. REPORT 1. AUTOMOBILE OCCUPANCY

Federal Hwy. Administration

H. E. Strate

Rept. 2 is HS-012 691.

Corporate author

\*Automobile occupancy, \*Automobile usage, \*Trip purpose, \*Travel patterns, \*Vehicle mileage, \*Driver residence, \*Standard Metropolitan Statistical Areas, \*Day of week, \*Trip length, \*Time of day, \*Commuting patterns, \*Trip sharing, \*Surveys, \*Questionnaires,

Data concerning current automobile occupancy rates are presented and these figures are related to the major purpose of the trip, driver residence, population groupings of the Standard Metropolitan Statistical Areas, day of week, trip length, and time of day. Data collected in this survey included automobile trips, number of occupants on each trip, passenger miles, and vehicle miles, from all of which average occupancy rates were computed. It was found that average car occupancy for all trip purposes combined was 1.9 occupants per trip; average car occupancy varied from a high of 3.3 occupants per trip for vacation trips to a low of 1.4 occupants per trip for to and from work trips; average car occupancy generally increases with increasing trip length; average occupancy per automobile trip shows occupancy to be higher on weekends; one occupant trips represent 50.2% of all trips; and approximately 73.5% of trips to and from work were in one occupant cars.

HS-012 690

#### NATIONWIDE PERSONAL TRANSPORTATION SURVEY. REPORT 2. ANNUAL MILES OF AUTOMOBILE TRAVEL

Federal Hwy. Administration

H. E. Strate

Rept. 1 is HS-012 690; rept. 3 is HS-012 692.

Corporate author

\*Vehicle mileage, \*Automobile usage, \*Driver residence, \*Driver occupation, \*Vehicle age, \*Income, \*Socioeconomic data, \*Automobile ownership, \*Used automobiles, \*Questionnaires, \*Surveys, \*Standard Metropolitan Statistical Areas,

June 15, 1973

## VEHICLE SAFETY—Field 5

### Brake Systems—Group 5A

Data collected in this survey were used to study the effect of the number of cars in the household, automobile age, cars purchased new or used, annual income of the household, driver occupation, driver residence by incorporated places and unincorporated areas, and size of the Standard Metropolitan Statistical Area on automobile use expressed in average annual miles per vehicle. It was found that passenger automobiles average 11,600 miles annually; average annual mileage is directly related to the number of cars in the household and annual income of the household, and is inversely related to vehicle age; approximately 50% of cars are purchased new; considering all year-models, automobiles purchased as new appear to have higher average annual miles per vehicle than automobiles purchased as used; and vehicles operated by residents of incorporated areas account for nearly two-thirds of all vehicle miles of travel.

HS-012 691

#### NATIONWIDE PERSONAL TRANSPORTATION SURVEY. REPORT 3. SEASONAL VARIATIONS OF AUTOMOBILE TRIPS AND TRAVEL

Federal Hwy. Administration

For primary bibliographic entry see Fld. 2G.

HS-012 692

#### NATIONWIDE PERSONAL TRANSPORTATION STUDY. REPORT 4. TRANSPORTATION CHARACTERISTICS OF SCHOOL CHILDREN

Federal Hwy. Administration

Jr., D. A. Beschen

Rept. 3 is HS-012 692.

Corporate author

\*Travel patterns, \*Travel modes, \*Travel time, \*Children, \*Trip length, \*Surveys, \*Questionnaires, \*Trip purpose,

Students were classified according to three grade levels: elementary (kindergarten through sixth); intermediate (seventh and eighth), and senior (ninth through twelfth). For each grade level, home to school travel by various modes of transportation was analyzed in terms of distance to school and time from home to school. It was found that walk/bicycle and school bus were the most widely used modes of transportation; 42% walked/bicycled, approximately 38% used the school bus, 16% were driven to school, 3% used public transportation, and 2% drive to school; over two-thirds of all students made the one-way trip to school in less than 20 minutes; as students progressed from elementary to intermediate to senior grade levels, the distance and travel time from home to school increased; and for each of the three grade levels, students who resided in incorporated places traveled shorter distances and took less time to get to school than did students from unincorporated areas.

HS-012 693

## 5. VEHICLE SAFETY

### 5A. Brake Systems

#### UPGRADING BRAKING SYSTEMS TO MEET FEDERAL STANDARDS

V81 N3

See serial citation

\*Brake standards, \*Brake design, \*Brake tests, \*Brake performance, \*Stopping distance, \*Brake fade, \*Test facilities, \*Brake lining materials, \*Compliance tests, \*Truck brakes, \*Pickup trucks,

Although the braking performance of U. S. vehicles has improved steadily in recent years, even greater improvements will be necessary to meet government regulations such as FMVSS 105 and 121 and subsequent revisions. Shorter stopping distances, higher deceleration rates, and resistance to fading required by the standards will result in heavier duty and more sophisticated systems. Some problems in designing brakes to meet the standards and proposed solutions raised by leading engineers from industry and government are presented.

HS-012 676

#### COMPONENT DEGRADATION: BRAKE SYSTEM PERFORMANCE, VOL. 1. SUMMARY REPORT

Bendix Corp.

T. W. KeranenR. T. DuCharmeC. C. Matle6253

Contract DOT-HS-090-1-124

Report for 20 May 1971 - 20 May 1972. Vol. 2 is HS-800 751.

NTIS

For abstract and search terms see HS-800 751.

HS-800 750

#### COMPONENT DEGRADATION: BRAKE SYSTEM PERFORMANCE. VOL. 2. FINAL TECHNICAL REPORT

Bendix Corp.

T. W. KeranenR. T. DuCharmeC. C. Matle6254

Contract DOT-HS-090-1-124

Report for 20 May 1971-20 May 1972. Vol. 1 is HS-800 750; Vol. 3 is HS-800 791.

NTIS

\*Disc brakes, \*Drum brakes, \*Brake performance, \*Brake tests, \*Performance tests, \*Wear tests, \*Dynamometers, \*Computerized simulation, \*Benefit cost analysis, \*Brake inspection, \*Brake wear, \*Brake discs, \*Brake drums, \*Friction materials, \*Materials tests, \*Test facilities, \*Brake linings, \*Brake torque, \*Contaminants, \*Reviews, \*Bibliographies,

Brake component and system performance limits of degradation are recommended and a cost-effective means of brake system inspection is determined. The modes of brake degradation evaluated were one front brake contaminated with brake fluid and wheel bearing grease, worn friction materials, thin discs, and thin drums. The evaluation of brakes from one large and one intermediate size automobile was conducted on a two-wheel inertial dynamometer. The dynamometer results were converted into vehicle braking performance with a vehicle handling model and a hybrid computer. The testing approach was verified with vehicle braking tests. A literature survey was conducted and a bibliography is presented.

HS-800 751

#### COMPONENT DEGRADATION: BRAKE SYSTEM PERFORMANCE. VOL. 3--DATA COLLECTION. FINAL REPORT

Bendix Corp.

T. W. KeranenR. T. DuCharmeC. C. Matle6255

Contract DOT-HS-090-1-124

Vol. 2 is HS-800 751.

## Group 5A—Brake Systems

## NTIS

\*Disc brakes, \*Drum brakes, \*Brake tests, \*Friction materials, \*Computerized simulation, \*Dynamometers, \*Wear tests, \*Performance tests, \*Brake performance, \*Brake drums, \*Brake discs, \*Brake lining, \*Thermography, \*Brake thermal factors, \*Durability tests, \*Chrysler Imperial, \*Ford Torino, \*Speed, \*Brake fade,

Results are charted for vehicle baseline and contaminated friction materials tests of a Chrysler Imperial with disc front and drum rear brakes and a Ford Torino with front and rear drum brakes. Results of dynamometer tests and computer study of baseline information and contaminated friction materials were charted for both vehicles. Charts of dynamometer tests and computer study of worn friction materials and thin brake discs and drums on the Imperial, and thin friction materials and brake drums on the Torino are also included. Thermogram data for simulated thin brake linings and endurance tests of used linings are presented.

HS-800 791

## ESV DYNAMIC PERFORMANCE

National Hwy. Traf. Safety Administration

F. A. Di LorenzoSAE-730080

Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

SAE

\*Experimental vehicles, \*Safety cars, \*Vehicle performance, \*Performance tests, \*Brake tests, \*Brake performance, \*Steering tests, \*Vehicle handling, \*Braking forces, \*Pedal force, \*Braking distance, \*Yaw, \*Vehicle control, \*Vehicle stability, \*Crosswind, \*Pavement surface texture, \*Turning radius, \*Rollover tests, \*Lateral acceleration, \*Wet road conditions, \*Dry road conditions, \*Tire inflation pressure,

Brake performance tests were performed on two experimental safety vehicles (ESV) to determine stopping distances and pedal forces from 60 mph stops for normal and off-design loads, for wet and dry pavements, and for normal and emergency modes. The steering tests used for evaluation of two ESV's consisted of the steady-state yaw response, the transient yaw response, and a returnability maneuver. All three tests were run at a lateral  $g$  of 0.4. Vehicle handling tests measured the performance of a vehicle when acted upon by outside influences--off-design tire pressure, crosswinds, and pavement irregularities. Control at breakaway, steering sensitivity, and rollover immunity tests were also conducted. Test results are presented graphically and will be used to determine future ESV specifications.

HS-820 257

## 5C. Cycles

## MOTORCYCLES

V38 N1

See serial citation

\*Motorcycle safety, \*Motorcycle characteristics, \*Motorcycle handling, \*Motor safety standards, \*Motorcycle performance, \*Protective clothing, \*Helmets, \*Helmet standards, \*Motorcycle visibility, \*Defensive driving, \*Impact tests, \*Motorcycle operator injuries, \*Motorcycle brakes, \*Experimental vehicles,

Accident statistics indicate that motorcycles are far more dangerous than cars. However, a motorcyclist can minimize accident risks by intelligent selection of his motorcycle; by using available safety equipment; and by riding defensively. Guidelines for selecting a vehicle and motorcycle helmet are presented. The value of protective clothing and headgear in injury prevention is emphasized. Defensive riding and methods of improving motorcycle visibility are also discussed. Federal efforts in improving motorcycle safety include impact testing and the introduction of several new standards that would affect motorcycle design in the coming years. Among them are Standard 108, which includes turn signals among its requirements; Standard 122, which specifies strict equipment and performance standards for motorcycle braking systems; and Standard 123, which requires standardization of important controls and instruments on motorcycles. There is also the possibility of a program for the development of experimental safety motorcycles.

HS-012 664

## 5D. Design

## THE CRASHWORTHINESS OF AUTOMOBILES

V228 N2

P. M. Miller

See serial citation

\*Crashworthiness, \*Automobile design, \*Automobile modification, \*Energy absorbing front structures, \*Vehicle pedestrian collisions, \*Human deceleration tolerances, \*Restraint system effectiveness, \*Three point restraint systems, \*Injury severity index, \*Glass fracture behavior, \*Energy absorbing side structures, \*Air bag restraint systems, \*Restraint system usage, \*Passenger compartments, \*Crashworthy bodies, \*Honeycomb structures, \*Accident analysis, \*Impact tests, \*Impact severity, \*Impact velocity, \*Impact angle, \*Padding, \*Fire walls, \*Windows, \*Grilles, \*Headers, \*Dummies, \*Safety glass, \*Urethane bumpers, \*Roof supports, \*Injury prevention, \*Fatality prevention, \*Occupant protection, \*Restraint system tests, \*Seat belts, \*Energy absorbing materials, \*Structural design,

Calspan Corporation's suggested changes in automobile design for greater safety include a crushable front end and a reinforced passenger compartment. Research has concentrated on reducing impact severity in vehicle pedestrian collisions; specialized designs for crashworthiness, one for automobiles used in urban areas, the other for rural use; and refining crashworthy automobiles so that they are no more aggressive than conventional cars in a collision with a full-size or subcompact car. Human deceleration tolerances were measured, and test results indicate that at present air bags cannot compare in effectiveness with belts and harnesses. Front end modifications, including use of honeycomb structures, urethane bumpers, and energy absorbing grilles have been tested to prevent intrusions into the passenger compartment.

HS-012 645

## SAE FOLLOW-UP: WHO GETS THE NOD--ESV'S OR URBAN CARS?

V9 N2

J. Norbye

See serial citation

\*Experimental automobiles, \*Safety cars, \*Foreign automobiles, \*European vehicles, \*Japanese vehicles, \*Vehicle weight, \*Vehicle safety standards, \*Urban automobiles,

Several experimental safety vehicles (ESV's) and urban cars were displayed at the 1973 Society of Automotive Engineers Congress and Exposition. Features of the Fiat, Mercedes-Benz and Volkswagen ESV's are briefly discussed. Problems which ESV designers will have to deal with, in light of the emission control standards, the impending fuel shortage, and the cost and supply situation concerning all raw materials used by the auto industry, include the excessive weight, costs, and poor fuel economy of the ESV's. In the Urban Vehicle Design Competition at the Congress the overall winner was a car from the University of British Columbia in Vancouver. A modified Volkswagen, converted to run on hydrogen fuel with water injection for nitrogen oxides control, prepared by students from Brigham Young University, won the emission control test.

HS-012 649

### SAFETY: FACT, FANTASY OR CON

V11

F. Costin

See serial citation

\*Vehicle safety, \*Safety laws, \*Occupant protection, \*Crash-worthiness, \*Vehicle design, \*Restraint systems, \*Kinetic energy, \*Experimental vehicles, \*Safety cars, \*Vehicle weight,

The practical validity of safety legislation is examined. Not only does safety cost hundreds of millions of dollars annually, it is also restrictive in that engineers have to comply with regulations which have little to do with keeping people alive. Occupant protection must be given priority and the use of restraints is a prerequisite to safety design. Experimental safety vehicle weight and its adverse effect on maneuverability are discussed. Kinetic energy in relation to vehicle weight and speed is plotted.

HS-012 650

### A CRITIQUE OF THE NHTSA DEFECT INVESTIGATION OF THE 1960-1963 CORVAIR HANDLING AND STABILITY

Public Interest Res. Group

For primary bibliographic entry see Fld. 5Q.

HS-012 657

### VEHICLE SIZE AND ACCIDENT INVOLVEMENT: A PRELIMINARY STUDY

For primary bibliographic entry see Fld. 1C.

HS-012 667

### EXPLORATORY EVALUATION OF CERAMICS FOR AUTOMOBILE THERMAL REACTORS

Lewis Res. Center

P. L. StoneC. P. BlankenshipNASA-TM-X-68148; N73

Prepared for presentation at International Automotive Engineering Congress and Exposition, Detroit, 8-12 Jan 1973.

Corporate author

\*Ceramics, \*Thermal reactors, \*Materials tests, \*Durability tests, \*Road tests, \*Engine dynamometers, \*Glass, \*Temperature,

Potential ceramic materials were evaluated in several reactor designs using both engine dynamometer and vehicle road tests. Silicon carbide contained in a corrugated metal support structure exhibited the best performance lasting over 800 hours in engine dynamometer tests and over 15,000 miles (24,200 KM)

of vehicle road tests. Reactors containing glass-ceramic components did not perform as well as silicon carbide. But the glass-ceramics still offer good potential for reactor use. The results of this study are considered to be a reasonable demonstration of the potential use of ceramics in thermal reactors.

HS-012 672

### AUTOMOTIVE DESIGN TRENDS

V17 N1

J. Hartley

See serial citation

\*Automobile design, \*European vehicles, \*Vehicle size, \*Engine location, \*Transmission design, \*Rotary piston engines, \*Engine design, \*Valves, \*Cylinders, \*Exhaust emission control devices, \*Fuel injection, \*Fuel systems, \*Valve timing, \*Valve lifters, \*Cams, \*Diesel engines, \*Turbocharging, \*Automatic transmissions, \*Suspension systems, \*Shock absorbers, \*Wheel bearings, \*Automobile stability, \*Front wheel drives, \*Rear wheel drives, \*Engine performance, \*Automobile models, \*Exhaust emission standards, \*Carburetor design,

The effect of legislation on design is reviewed. The advantages of front wheel drive and engine location in European automobiles are discussed. Wankel and Karol rotary engines are compared. Exhaust emission control dominates engine design, and use of four valves per cylinder enables high performance engines to give low emissions without great power loss. To meet future European regulations, modified carburation, combustion chamber design, and ignition systems will be required. To meet U. S. regulations after 1975, catalytic converters are needed. Fuel injection systems, variable valve lifting and timing systems, and use of turbocharging in diesel engines to reduce emissions are discussed. Developments in automatic and semi-automatic transmissions are outlined. Suspension system and wheel bearing design for increased vehicle stability are discussed.

HS-012 678

### ROTARIES: MORE TO COME?

V143 N3671

A. Curtis

See serial citation

\*Rotary engines, \*Engine design, \*Rotary piston engines, \*Engine performance, \*Combustion, \*Cylinders, \*Rotors, \*Engine housings, \*Seals, \*Pistons,

A rotary engine should have excellent inherent dynamic balance and thus run more smoothly than its equivalent rival; it should be less bulky than an ordinary engine; it should have fewer moving parts arranged so as to give reduced maintenance and greater reliability; and it should not require exotic techniques, materials, or manufacturing methods so that it can be cheaper to produce. The operation of the Anidyne, Clarke, Huf, and Sarich rotary engines is described.

HS-012 695

### VSDSS RESEARCH STUDIES. FINAL REPORT

New York State Dept. of Motor Vehicles

Contract FH-11-6799

NTIS



\*Data banks, \*Accident studies, \*Accident prevention, \*Injury prevention, \*Automobile design, \*Occupant protection, \*Accident rates, \*Accident statistics, \*Accident risks, \*Injury severity, \*Injury rates, \*Energy absorbing steering columns, \*Seat belt effectiveness, \*Seat belt usage, \*Energy absorbing front structures, \*Steels, \*Fiberglass, \*Injuries by vehicle make, \*Vehicle mileage, \*Vehicle age, \*Injuries by vehicle age, \*Accidents by body types, \*Pedestrian accidents, \*Out of state drivers, \*Engine size, \*Highway characteristics, \*Automobile colors, \*Rear visibility, \*Damage severity, \*Driver age, \*Driver sex, \*Driver injuries, \*Rear wheel drives, \*Front wheel drives, \*Rear engine automobiles, \*Front engine automobiles, \*Accident types, \*Time of accidents, \*Accident records, \*Chi square test, \*Variance analysis, \*T test, \*Sidemarkers lamps, \*New York (State), \*Accident causes, \*Automobile models, \*Injury causes, \*Seasons,

The Vehicle Safety Design Surveillance System (VSDSS) is an accident data bank established by the New York State Department of Motor Vehicles to study the relationship between vehicle design and traffic accidents and injuries. This report presents 17 studies which were carried out utilizing the information contained in the VSDSS. Areas studied included: the injury prevention effectiveness of collapsible steering columns, seat belts, and controlled crush front ends; effects of steel body shells, fiber glass body shells, and front and rear engine vehicle designs on injury severity; accident involvement rates (AIR) of vehicles by body style, cylinder number, color, and type of drive system; effectiveness of sidemarkers lamps in intersection accident prevention; AIR of fastback cars; techniques for estimating vehicle mileage; the role of vehicle age, out of state drivers, and highway characteristics on accident causation; pedestrian accidents; and validation of the VSDSS data bank.

HS-800 780

#### **AUTOMOTIVE TAPE RECORDER. VOL. 4. INSTALLATION, MAINTENANCE AND REMOVAL. FINAL REPORT**

AVCO Corp.

R. C. Baker AVSD-0135-72-CR

Contract FH-11-7603

Report for Feb-Nov 1972. Vol. 3 is HS-800 807; Vol. 5 is HS-800 809

NTIS

\*Tape recorders, \*Instrumented vehicles, \*Instruction manuals, \*Accelerometers, \*Pressure transducers, \*Speed sensors, \*Potentiometers, \*Braking recorders, \*Sensors, \*Wiring, \*Maintenance, \*Automobile models, \*Electronic monitoring systems, \*Steering systems,

The Automotive Tape Recorder (ATR) is an electro-mechanical system designed to sense, measure, and record several parameters within an automobile. In a collision the ATR will provide a permanent record of acceleration in three axes, steering wheel motion, front brake line pressure, and vehicle speed for the period immediately prior to and during the collision. This volume discusses and illustrates in detail the installation procedures for the ATR. Installation is shown for the Ford LTD, Ford Torino, Plymouth Fury, Chevrolet Impala, American Motors Ambassador, and American Motors Matador. The installation instructions include mechanical and electrical interfaces with the vehicles and checkout procedures to assure proper installation. Procedures for removal of the equipment

from the vehicles and for the maintenance of the equipment are also included.

HS-800 808

#### **5F. Fuel Systems**

#### **THE SEARCH FOR ALTERNATIVE AUTOMOTIVE POWER SOURCES**

For primary bibliographic entry see Fld. 5O.

HS-012 646

#### **EMISSION PREDICTION AND CONTROL STRATEGY: EVALUATION OF POLLUTION FROM TRANSPORTATION SYSTEMS**

V23 N2

R. E. Wendell J. E. Norco K. G. Croke

Supported in part by Illinois Inst. of Environmental Quality, Environmental Protection Agency, National Science Foundation, and Ohio State Univ.

\*Vehicle air pollution, \*Air pollution emission factors, \*Emission control, \*Air pollution emission tables, \*Exhaust emissions measurement, \*Evaporative emission measurement, \*Cold-starts, \*Traffic characteristics, \*Traffic distribution models, \*Vehicle mileage, \*Vehicle registration, \*Carbon monoxide, \*Nitrogen oxides, \*Hydrocarbons, \*Chicago, \*Mathematical models, \*Transportation regulations, \*Central business districts,

The determination of a vehicle air pollution control strategy must include consideration of alternatives such as parking restrictions, staggered work hours, promotion of mass transportation, commuter taxes, and gasoline rationing. The total systems approach in analyzing these alternatives, based on the development of two models, a vehicle emissions model and an urban transportation model is presented. The vehicle emissions model, which takes a new approach to vehicle emissions by distinguishing between hot and cold vehicle operation, is reviewed. The method of integration of the vehicle emissions model to an urban model is also discussed and illustrated with data from the Chicago Area Transportation Study. The combining of the models into an emission simulation technique and subsequent policy evaluation of urban emission reduction strategies is illustrated. Among the results is an examination of the significance of mobile pollution sources and control strategies in the central business district of Chicago.

HS-012 655

#### **EUROPE SEEKS COMMON SOLUTIONS TO PROBLEMS OF EMISSIONS AND NOISE**

V81 N3

Based on the report, Automotive Air Pollution and Noise: Implications for Public Policy, Organization for Economic Co-operation and Development, Paris, Oct 1972.

See serial citation

\*Emission control, \*Noise control, \*International compacts, \*Exhaust emission standards, \*Noise standards, \*Law uniformity, \*Vehicle air pollution, \*Acoustic measurement, \*Sound intensity, \*Exhaust densities, \*Population density, \*Air pollution effect on health, \*Europe, \*Toxicity, \*Blood lead levels, \*Fuel composition, \*Octane requirements, \*Fuel quality, \*Standardization, \*Emission control device certification, \*Compliance tests, \*Emission tests, \*Benefit cost analysis,

\*Air pollution control costs, \*International factors, \*Air pollutants, \*Noise control costs, \*Fines, \*Air pollution law violations, \*Automobile bans, \*Traffic control, \*Rural areas, \*Urban areas, \*Air pollution dispersion, \*Exhaust emissions measurement,

An internationally uniform emission testing procedure for new cars, reciprocal recognition of emission test results for purposes of certification, and international agreement on the status of lead in motor fuel would benefit international vehicle trade and travel, although nations are not likely to give up their right to set their own standards. Air pollution effects on health, particularly the effects of airborne lead, are discussed. Cost effectiveness of controlled cars, and the effect of imposing fees for emission level violations and automobile bans are considered. European noise and emission standards are more lenient than U. S. standards. Most European countries intend to follow emissions standards recommended by the Economic Commission for Europe. Only nine European nations have significant vehicle noise level standards. Air pollutant concentrations and noise levels for urban areas were measured. Problems of dual emissions standards for vehicles used primarily in urban or in rural areas are outlined.

HS-012 674

#### ULTRASONIC FUEL SYSTEMS PROMISE CLEANER EXHAUST AND BETTER MILEAGE FROM STANDARD PISTON ENGINES

V202 N3

J. P. Norbye

See serial citation

\*Fuel systems, \*Ultrasonic devices, \*Exhaust emission control devices, \*Electronic fuel injection, \*Atomizing, \*Reactors, \*Air fuel ratio, \*Nozzles, \*Frequencies, \*Exhaust emission tests, \*Fuel economy, \*Computers,

A computer controlled ultrasonic fuel system is described. This fuel system uses the energy of sound waves to break up the fuel into microscopically small but uniform particles, thereby achieving intensive atomization and an even dispersal of fuel in the air flow. Thus the engine gets an ideal and constant-ratio air/fuel mixture which assures more complete combustion and lower emission levels. Tests conducted on a Plymouth Duster equipped with an ultrasonic fuel system resulted in exhaust emissions which are well below carbon monoxide limits for 1975 and 1976, close to hydrocarbon limits for both years, and beat the 1975 limit on nitrogen oxides by a wide margin. The new fuel system also increased fuel economy by 22 to 28%.

HS-012 677

#### CHARACTERIZATION OF PARTICULATE MATTER IN VEHICLE EXHAUST

v7 n3

K. Habibi

Presented at Symposium on Science in the Control of Smog, California Inst. of Tech., Pasadena, Calif., 15-16 Nov 1971. See serial citation

\*Particulate air pollutants, \*Exhaust emission measurement, \*Exhaust emission tests, \*Exhaust emission sampling, \*Particle size analysis, \*Lead, \*Carbon, \*Filters, \*X ray analysis, \*Light scattering, \*Leaded gasoline, \*Lead free gasoline, \*Fuel composition, \*Chassis dynamometers, \*Particulate traps, \*Vehicle mileage, \*Coldstarts, \*State of the art studies, \*Aerosols,

The particulate matter emitted from present-day cars is a complex mixture of inorganic salts, soot, and carbonaceous material. Measurement and characterization of such particles require elaborate sampling systems and sophisticated analytical techniques. This paper is a review of the major contributions in this area. A number of systems suitable for sampling and characterization of the exhaust particles are described. Particulate emission rate data are included.

HS-012 696

#### FORMATION OF HYDROCARBONS AND OXIDES OF NITROGEN IN AUTOMOBILE ENGINES

V7 N3

J. B. Heywood J. C. Keck

Grant 5-R01-AP01228-02-APC GK15409

Presented at Symposium on Science in the Control of Smog, California Inst. of Tech., Pasadena, Calif., Nov 1971.

See serial citation

\*Hydrocarbons, \*Nitrogen oxides, \*Exhaust composition, \*Combustion products, \*Spark ignition engines, \*Thermodynamics, \*Kinetics, \*Mathematical models, \*Gas dynamics, \*Aerodynamics, \*Combustion chamber wall angles, \*Exhaust emission sampling, \*Engine operating conditions, \*Engine design, \*Unburned fuels, \*Cylinder gases, \*Pistons, \*Cylinder heads,

The basic mechanisms responsible for the production of nitrogen oxide and hydrocarbon emissions from automotive spark-ignition engines are reviewed. It is shown how the formation of nitric oxide is rate controlled in the high-temperature burned gases inside the engine cylinder. A mathematical model which predicts nitric oxide emissions for given engine design and operating variables is then described. In contrast, the hydrocarbons are formed when the flame quenches at the cylinder head and piston walls. The magnitude of these quench layers and crevices and the boundary layer aerodynamics by which the hydrocarbon-rich gases exit the cylinder are discussed.

HS-012 704

#### 5I. Inspections

##### INSPECTION OF MOTOR VEHICLES IN BLOOMINGTON, INDIANA AND MONROE COUNTY, VOL. 2. FINAL TECHNICAL REPORT

Ultrasystems, Inc.

Jr., F. G. Fisher R. Eidemiller P. Biche US-81205-2

Contract DOT-HS-094-1-130 1

Report for Jun 1971-Mar 1972. For summary see HS-800 772.

NTIS

\*Mobile inspection stations, \*Vehicle inspection, \*Inspection equipment, \*Indiana, \*Manuals, \*Vehicle sampling, \*Statistical analysis, \*Computerized test methods, \*Chi square test, \*T test, \*Data acquisition, \*Data banks, \*Data processing, \*Data analysis, \*Vehicle age, \*Vehicle mileage, \*Failures, \*Design of experiments, \*Inspector training,

This study was conducted to establish the safety status of the vehicle-in-use population of Bloomington, Indiana and the surrounding Monroe County. The Mobile Inspection Facility was utilized to collect the data. The vehicle sample was drawn by randomized sampling techniques and was partitioned such that

## Group 5I—Inspections

it is representative of both the national vehicle profile and the Indiana vehicle profile. All aspects of the van operations were evaluated. A computer program was designed for analysis and presentation of the data. It was concluded that the van provides an effective means of collecting large samples of data in a limited period of time; and that there is a definite need to revise the manuals and to replace certain items of equipment supplied with the van. The major problem incurred in performing the study concerned acquiring a high enough response rate from vehicle owners to meet the vehicles/day inspection capacity of the van.

HS-800 773

## 5J. Lighting Systems

### THE VISIBILITY AND AUDIBILITY OF TRAINS APPROACHING RAIL-HIGHWAY GRADE CROSSINGS. FINAL REPORT

Systems Consultants, Inc.

For primary bibliographic entry see Fld. 2D.

HS-012 660

## 5N. Occupant Protection

### IMPROVING OCCUPANT RESTRAINT SYSTEMS

Triumph Motor Co. (England)

D. P. Peck

In HS-012 296

\*Restraint system usage, \*Ignition seat belt interlocks, \*Air bag restraint systems, \*Automatic seat belts, \*Restraint system effectiveness, \*Seat belt usage laws, \*Benefit cost analysis,

An estimated 60% of all deaths and serious injuries could be avoided if seat belts were universally worn. The actual usage rate is only between 15 and 20% however and although various user education programs are introduced from time to time no substantial, permanent improvement is achieved. Therefore improvement in restraint usage can only come from some element of compulsion. This compulsion can be achieved by one of three approaches: by legislation--enforcing the use of seat belts, by mechanical necessity--operation of the vehicle dependent on correct use of belts, or by automatic restraint deployment--passive belts or air bags. An ignition seat belt interlock system and door operated seat belts developed by the British Leyland Motor Corp. Ltd. are described. The components of an air bag restraint system are discussed in more detail. Cost benefit factors are included for each system discussed.

HS-012 619

### THE CRASHWORTHINESS OF AUTOMOBILES

For primary bibliographic entry see Fld. 5D.

HS-012 645

### SAFETY: FACT, FANTASY OR CON

For primary bibliographic entry see Fld. 5D.

HS-012 650

### A STUDY OF EFFECTIVENESS OF A RADIO/TV CAMPAIGN ON SAFETY BELT USE

V5 N1

G. A. Fleischer

Contract DOT-HS-010-1012

See serial citation

\*Seat belt campaigns, \*Seat belt usage, \*Safety program effectiveness, \*Television, \*Radio programs, \*Attitudes, \*Public opinion, \*Modesto, \*Salinas, \*Bakersfield, \*Costs,

A broadcast media campaign was developed in the spring of 1971. Broadcast materials, selected in part on the basis of reviews by expert and lay panels, were distributed to selected radio and TV stations for subsequent broadcast as public service announcements (PSA's). Unobtrusive observations of safety belt use were made in two demographically matched communities, Modesto and Salinas, California, immediately prior to the campaign (two weeks), during the campaign (five weeks), and immediately subsequent to the campaign (four weeks). Community attitudes towards safety belts were determined through telephone interviews. Measurements were also made in a control community, Bakersfield, California, in which no materials were broadcast. On the basis of over 22,000 vehicle observations (28,000 occupants) and 2,000 telephone interviews, it was concluded that PSA's had little significant effect on safety belt use or related attitudes. The cost of the campaign is commented on.

HS-012 665

### DYNAMIC TESTS OF A YIELDING SEAT BELT SYSTEM

Aeronautical Res. Labs. (Australia)

S. R. SarraillheARL/SM.340

Corporate author

\*Restraint system tests, \*Three point restraint systems, \*Energy absorption, \*Impact tests, \*Seat belt loading, \*Seat loading, \*Restraint system effectiveness, \*Test equipment, \*Anthropomorphic dummies, \*Shoulder harnesses, \*Acceleration, \*Deceleration, \*Impact forces, \*Occupant kinematics, \*Static loads, \*Tension (mechanics), \*Oscillographs,

The performance of seat belts can be improved by incorporating energy absorbers to allow the system to yield at constant force. The principle can be applied to the whole system or to critical components. Dynamic tests were carried out with lap/shoulder seat belts incorporating energy absorbers in the shoulder straps. For comparison, conventional assemblies were also tested. The tests showed that with energy absorbers allowing an increase in dummy movement of five inches or less the shoulder strap forces could be reduced by 30%. Alternatively, energy absorbers allowed an increase of 50% on the input deceleration without increase in shoulder strap force. It was considered that energy absorption in the seat and lap belts could allow similar improvement in these components. The load distribution between the straps and the friction force between the dummy and seat was examined and it was found that the seat force was of similar magnitude to the combined lap strap forces.

HS-012 685

### PROTECTION OF THE HEAD

Royal Air Force Inst. of Aviation Medicine (England)

J. A. Gillies

Presented at the Aerospace Medical Panel Specialist Meeting, AGARD Conference on Linear Acceleration of Impact Type, Oporto, Portugal, 23-26 Jun 1971.

See serial citation

\*Head protection, \*Helmets, \*Aircraft accidents, \*Head injuries, \*Helmet impact tests, \*Helmet standards, \*Injury preven-

June 15, 1973

## VEHICLE SAFETY—Field 5

### Safety Defect Control—Group 5Q

tion, \*Accident survivability, \*Helmet design, \*Great Britain, \*Ejection, \*Head acceleration tolerances, \*Head impact tolerances, \*Head forms,

Head injuries are common in all aviation accidents as well as other military and sporting activities. Protective helmets developed to ameliorate the effects of head impacts, improve survival and reduce injury in aircraft accidents, but would be aided by improvements in restraint systems and better work-space design. Ejection from aircraft and subsequent parachute descent carry high risks of head impact. Aircrew protective helmets should continue to be designed to deal with high energy rather than repetitive low energy blows. The multiple functions of helmets make it difficult to meet all requirements without excessive size and weight. Reduction in both weight and size would be desirable but current standards of protection should be maintained. Helmet impact test methods should take account of accident findings and involve a small number of high energy blows.

HS-012 687

#### EVALUATION OF THE EFFECTS OF A SEAT BELT EDUCATION PROGRAM AMONG ELEMENTARY SCHOOL CHILDREN IN LOUDOUN COUNTY, VIRGINIA. FINAL REPORT

National Analysts, Inc.  
S. A. SenkS. L. Schwartz  
Contract DOT-HS-200-2-320  
NTIS

\*Seat belt campaigns, \*Child safety education, \*Safety program effectiveness, \*Seat belt usage, \*Maryland, \*Virginia, \*Seat belt usage by seat occupation, \*Sampling, \*Data acquisition, \*Age factors, \*Interviews,

Before, during, and after the seat belt education program, passengers and drivers of cars with children of elementary school age were observed in and near shopping centers in Loudoun County and in a control county, Prince Georges County, Maryland. There was an increase in seat belt usage among Loudoun County elementary school children, from the pre- to post-program periods, and no increase (actually, a decrease occurred) in Prince Georges County. There were no increases in usage among older children or among adults, indicating no substantial diffusional effect on parents, or older siblings. Also, many children and their teachers in Loudoun County claimed to have increased their usage of seat belts.

HS-800 766

#### VSDSS RESEARCH STUDIES. FINAL REPORT

New York State Dept. of Motor Vehicles  
For primary bibliographic entry see Fld. 5D.  
HS-800 780

#### VSDSS RESEARCH STUDIES. FINAL REPORT

New York State Dept. of Motor Vehicles  
For primary bibliographic entry see Fld. 5D.  
HS-800 780

#### STATISTICAL ANALYSIS OF SAFETY BELT USAGE IN THE STATE OF OREGON. PRELIMINARY REPORT

National Hwy. Traf. Safety Administration

H. A. Richardson  
Reference copy only

\*Seat belt usage, \*Three point restraint system usage, \*Restraint system effectiveness, \*Ejection, \*Statistical analysis, \*Injury prevention, \*Injury rates, \*Fatality rates, \*Injury severity, \*Age factors, \*Seat belt usage by seat occupation, \*Vehicle age, \*Sex factors, \*Ejection caused injuries, \*Time of day, \*Road conditions, \*Seasons, \*Weather, \*Speed, \*Damage severity, \*Injuries by seat occupation, \*Oregon, \*Accident severity,

A preliminary study of motor vehicle accidents to determine safety belt usage and effectiveness was conducted. The sample studied consisted of 5,565 passenger vehicle accidents which were investigated by the Oregon Highway Patrol between July 1, 1970, and June 30, 1971. In general it was found that 31% of the occupants of passenger vehicles involved in these accidents used occupant belt restraints; safety belt usage regardless of type of belt worn was associated with a 22% reduction in the incidence of overall occupant injury; and 3.6% of the unbelted occupants were ejected while only 0.4% of the belt users become ejectees. More detailed findings regarding seat belt usage by vehicle age, occupant age and sex, seat position, time of day, season, road conditions, damage severity, weather, and speed; seat belt effectiveness by vehicle age and seat position; and the relationship between ejection and injury severity are presented.

HS-820 249

### 5O. Propulsion Systems

#### THE SEARCH FOR ALTERNATIVE AUTOMOTIVE POWER SOURCES

V148 N4  
R. H. EshelmanH. M. NelsonJ. B. Pond  
See serial citation

\*Experimental engines, \*Exhaust emission control, \*Wankel engines, \*Gas turbine engines, \*Rankine cycle engines, \*Electric vehicles, \*Stirling engines, \*Diesel engines,

Progress in developing vehicle power systems to meet future noise and pollution standards is reviewed. Advantages and problems of the Wankel engine and the gas turbine engine are discussed. Other alternative power systems mentioned include diesel engines, Rankine cycle engines, Stirling engines and electrically powered vehicles.

HS-012 646

### 5Q. Safety Defect Control

#### A CRITIQUE OF THE NHTSA DEFECT INVESTIGATION OF THE 1960-1963 CORVAIR HANDLING AND STABILITY

Public Interest Res. Group  
C. E. Nash  
Corporate author \$5.00

\*Corvairs, \*Federal role, \*Automobile handling, \*Automobile stability, \*Swing axles, \*Vehicle age, \*Automobile design, \*Vehicle safety standards, \*Safety standards compliance, \*Performance tests, \*Vehicles dynamic, \*Rear end loading, \*Heaters, \*Leakage tests, \*Degradation failures, \*Lateral acceleration, \*Brake tests, \*Steering tests, \*Vehicle control,

## Group 5Q—Safety Defect Control

\*Cornering, \*Compliance tests, \*Dynamic tests, \*Oversteer, \*Understeer, \*Proving ground tests, \*Accident avoidance, \*Rollover tests, \*Manufacturers liability, \*Jacking, \*Defect correction, \*Tire inflation pressure, \*Defects,

The NHTSA investigation was evaluated by three outside engineers empanelled by NHTSA on September 15, 1971. NHTSA was aware that finding a defect in Corvair handling and stability could require a similar finding for the Volkswagen Beetle, Renault Dauphine, and other vehicles which would have led to demands for recall of one to two million vehicles. NHTSA ignored conflicts of interest among individuals responsible for conduct and review of the investigation except when there might have been a protest from General Motors. A comparison between Highway Safety Research Institute and Texas Transportation Institute (TTI) tests of Corvair handling and stability and suppressed data from Corvair tests performed for NHTSA at TTI are included. A gap existed between the level of training and competency of NHTSA and TTI engineers and technicians, none of whom had specialized training or were recognized experts in the field.

HS-012 657

## 5R. Steering Control Systems

### A CRITIQUE OF THE NHTSA DEFECT INVESTIGATION OF THE 1960-1963 CORVAIR HANDLING AND STABILITY

Public Interest Res. Group

For primary bibliographic entry see Fld. 5Q.

HS-012 657

### THE MEASUREMENT OF DRIVER DESCRIBING FUNCTIONS IN SIMULATED STEERING CONTROL TASKS

Systems Technology, Inc.

D. H. Weir C. K. Wojcik

Presented at meeting held at University of Southern California, Los Angeles, 2-4 Jun 1971.

NTIS in N73-10104

\*Driving simulation research, \*Driving simulators, \*Steering, \*Driving task analysis, \*Vehicle dynamics, \*Overtaking, \*Passing, \*Vehicle control, \*Crosswind, \*Tracking, \*Performance tests, \*Vehicle handling, \*Visual fields, \*Dynamometers, \*Equations of motion, \*Display systems, \*Parameters, \*Driver modeling, \*Vehicle stability, \*Lateral acceleration, \*Degrees of freedom, \*Lateral forces, \*Male drivers, \*Driver age, \*Driver experience,

Measurements were made using the Driving Simulator at UCLA which includes a 1965 Chevrolet sedan mounted on a chassis dynamometer, a moving model roadway and landscape, analog computation for vehicle handling dynamics, and a TV display system. The task was to regulate against a random crosswind gust on a straight roadway, in order to stay in the center of the lane. Five male drivers of varying age and driving experience were used. The forcing function and situation were configured so that an inner-loop visual cue feedback of heading angle or heading rate would dominate, and the driver's response was interpreted to be primarily single-loop. The driver describing functions were measured using a describing function analyzer. Three replications for each subject showed good repeatability within a subject. Results confirm the feasibility of

measuring operator response properties in nominal control tasks with full (real-world) visual field displays, and provide verification and quantification of existing engineering models for the driver and the driver/vehicle system.

HS-012 669

### HOW DETROIT IS 'TUNING' ITS NEW CARS FOR RADIAL TIRES

For primary bibliographic entry see Fld. 5V.

HS-012 673

### COMPUTER SIMULATION OF VEHICLE HANDLING, VOL. 1--FINAL SUMMARY REPORT

Bendix Corp.

6358-Summ

Contract FH-11-7563

NTIS

For abstract and search terms see HS-800 789

HS-800 788

### COMPUTER SIMULATION OF VEHICLE HANDLING. FINAL REPORT

Bendix Corp.

6358

Contract FH-11-7563

Summary rept. is HS-800 788.

NTIS

\*Automobile handling, \*Computerized simulation, \*Automobile modeling, \*Simulation models, \*Hybrid computers, \*Performance tests, \*Steering tests, \*Brake tests, \*Mathematical models, \*Fords, \*Station wagons, \*Volkswagens, \*Tire tests, \*Parameters, \*Rollover tests, \*Tire forces, \*Turning, \*Vehicle performance, \*Steering systems, \*Tire performance, \*Suspension systems, \*Shock absorbers, \*Rear axles, \*Coefficient of friction, \*Deceleration tests, \*Equations of motion, \*Tire pavement interface, \*Vehicle mass, \*Inertia, \*Vehicle center of gravity, \*Tire slip motion, \*Brake torque, \*Digital computers, \*Wheel performance, \*Damping, \*Roll, \*Tire mechanics, \*Braking,

The handling characteristics of a 1967 Ford Station Wagon and a 1971 Volkswagen Super Beetle were determined by simulation and by physical testing. The hybrid computer results were compared with subsequent test results to validate the simulation. Established Vehicle Handling Test Procedures were utilized to derive limits of vehicle performance. The simulation of Volkswagen handling accurately predicted the test results for straight line braking, braking in a turn, sinusoidal steering, and trapezoidal steering. Road holding and rollover tests imposed conditions which exceeded the available tire data and violated the assumptions of the suspension model so that quantitative prediction was compromised. The suspension model must be refined and more extensive tire data obtained for specific application to road holding and rollover tests. Simulation versatility has been enhanced to accurately model and evaluate solid and independently sprung rear axle vehicle characteristics.

HS-800 789

### ESV DYNAMIC PERFORMANCE

National Hwy. Traf. Safety Administration

For primary bibliographic entry see Fld. 5A.

HS-820 257

June 15, 1973

**VEHICLE SAFETY—Field 5**  
**Wheel Systems—Group 5V**

**5T. Trucks And Trailers**

**A REVIEW AND CRITIQUE OF SNOWMOBILE  
ACCIDENT REPORTS**

For primary bibliographic entry see Fld. 1E.  
HS-012 668

**5V. Wheel Systems**

**ADVANCES IN TIRE CORD PROCESSES. PT. 1:  
REINFORCING MATERIALS**

V105 N2

C. A. Litzler

Based on paper presented at American Inst. of Chemical Engineers National Meeting (73rd), Minneapolis, 28 Aug 1972.  
See serial citation

\*Tire cords, \*Tire design, \*Tire manufacture, \*Tire industry, \*Tire materials, \*Radial tires, \*Steel belted tires, \*Bias belted tires, \*Filament wound tires, \*Fiberglass, \*Polyester tires, \*Consumer demand forecasting, \*Nylon tires, \*Rayon tires, \*Fiber, \*Adhesion, \*Tire temperature tests, \*Production statistics,

The most important single factor of concern to the U. S. tire industry today is the rapid acceptance of wire-reinforced tires and textile-reinforced tires of radial design. The next most important factor is the increase in the use of fiberglass filament in either bias-belted or nearly true radial-belted construction. DuPont Fiber B has extremely good reinforcing properties for band and sidewall construction for radial and bias ply tires. The Japanese fiber polyvinyl alcohol (Kuraray), recently improved, may be a likely successor to present forms of rayon cord. Tire production capacities in major industrial areas of the world are tabulated and predictions for the U. S. market are included. Developments in reinforcing materials including DuPont Fiber B, polyester cord fiber, rayon cord, spun steel wire, and polyvinyl alcohol are discussed.

HS-012 648

**HOW DETROIT IS 'TUNING' ITS NEW CARS FOR  
RADIAL TIRES**

V139 N3

R. Lund

See serial citation

\*Radial tires, \*Tire characteristics, \*Automobile modification, \*Suspension systems, \*Tire riding characteristics, \*Tire performance,

Radial tires have several advantages: they can take impacts better than belted bias and bias ply tires and are less susceptible to puncturing; they are cool-running so there's less chance of a blowout; radials purge water better reducing risk of hydroplaning; there's less rolling resistance with radials, increasing fuel mileage; they are quieter-running tires; easier to steer; and radials give better resistance to side slip in crosswinds and on winding roads. However, radial tires have an inherent harshness that is transferred to the vehicle at low speeds. The car rides rough and noisy and any imperfections or impacts in the road are transferred to the vehicle. Ford Motor Co. has isolated radial tire vibrations by tuning engine, engine mounts, and front suspension for fore and aft stiffness. In the rear suspension, Ford uses a pan-hard rod which controls lateral stiffness of the suspension, and a bayonet-end attachment to get better control of lateral kick is also installed.

HS-012 673

**PRINCIPLES OF TIRE DESIGN**

V1 N1

W. W. Curtiss

Presented at Akron Rubber Group Symposium on Tire Mathematics, Akron, 23 April 1971.

See serial citation

\*Tire design, \*Structural analysis, \*Tire cords, \*Tire performance, \*Tire sizes, \*Tire shape, \*Tension (mechanics), \*Tire mechanics, \*Tire inflation pressure, \*Tire ply number, \*Tire beads, \*Tire manufacture, \*Drums, \*Curing, \*Tire tread patterns, \*Tire treads, \*Toroids, \*Pneumatic tires, \*Rims, \*Tire forces, \*Shear stress, \*Mathematical analysis, \*Bias belted tires, \*Strain (mechanics), \*Tensile strength,

An overview of the design process and calculations employed in developing the modern tire is presented. Performance and sizing, envelope shape as a function of construction, structural stress, design of the tire skin, and construction of the green tire are discussed.

HS-012 697

**RAPID TIRE WEAR MEASUREMENTS USING A  
TWO-WHEELED TRAILER**

V1 N1

E. Southern

Presented at American Society for Testing and Materials Com. F-9 Symposium on Tire Treadwear, Akron, 11 Nov 1971.

See serial citation

\*Tire wear, \*Tire wear measurement, \*Wear tests, \*Tire tests, \*Tire test equipment, \*Tire temperature, \*Rubber compounds, \*Tire tread depths, \*Tire materials,

A method has been developed using a two-wheeled trailer to obtain accelerated wear data on tires. The method is much quicker than conventional testing, and the results on a test car show good agreement with trailer results. The rate of wear can usually be established to within 5% so that small differences between compounds are readily detected. Tests on multi-section tires have been carried out but are not found to be a satisfactory way of increasing reliability. Results are normally presented in the form of a wear rating relative to a control compound, and the data shows that reversals in ranking occur as the conditions of test are changed to cause variations in the tire surface temperature.

HS-012 698

**ELEMENTS IN THE ROAD EVALUATION OF TIRE  
WEAR**

V1 N1

F. C. Brenner A. Kondo

Presented at American Society for Testing and Materials Com. F-9 Symposium on Tire Treadwear, Akron, 11 Nov 1971.

See serial citation

\*Tire wear, \*Road tests, \*Test tracks, \*Tire wear measurement, \*Tire treads, \*Tire tests, \*Wear tests, \*Mathematical models, \*Variance analysis, \*Design of experiments, \*Bias tires, \*Bias belted tires, \*Radial tires,

The procedural steps to be followed to achieve a treadwear evaluation are described and the results of such experiments are discussed. Concerning the design of the course, it is recommended that the course should: vary the terrain, the pavement composition, and its geometric features; demand a variety of vehicle maneuvers; wear tires at moderate rates for precise

## Group 5V—Wheel Systems

measurement and to insure that the test will extend over several weeks; and wear tires equally at front and rear for rear axle driven vehicles.

HS-012 699

**LABORATORY TIRE TREADWEAR TESTING**

VI N1

K. W. McIntosh

Presented at American Society for Testing and Materials Com. F-9 Symposium on Tire Treadwear, Akron, 11 Nov 1971.

See serial citation

\*Tire treads, \*Tire tests, \*Tire wear resistance, \*Tire wear measurement, \*Wear tests, \*Test equipment, \*Abrasion resistance, \*Tungsten carbides, \*Tire side forces, \*Road tests, \*Laboratory tests, \*Correlation analysis, \*Turning radius, \*Drums,

An attempt to duplicate road testing of tires on a laboratory treadwear tester is described. A tilting drum abrader using tungsten carbide gritted bars as an abrasive medium achieved limited success in slow wear testing of tires. Fast wear results could not be duplicated.

HS-012 700

**TESTING OF TIRE TREADWEAR UNDER LABORATORY AND UNDER SERVICE CONDITIONS**

VI N1

J. C. Ambelang

Presented in part at American Society for Testing and Materials Com. F-9 Symposium on Tire Treadwear, Akron, 11 Nov 1971.

See serial citation

\*Tire wear, \*Tire tests, \*Wear tests, \*Tire test equipment, \*Tire treads, \*Abrasion, \*Road tests, \*Environmental factors, \*Topographical factors, \*Laboratory tests, \*Tire loads, \*Ambient temperatures,

Four different laboratory machines for the evaluation of tire treadwear are described which use concrete, steel, and tungsten carbide abrasion surfaces at variable speed; and slip, but none has satisfactorily replaced highway testing. Predominant sources of wear on passenger tire appear to be cutting and frictional fatigue, the rates of which are influenced differently by temperature and load. Thus, seasonal or climatic, topographical, and geographical effects are evidenced. Treadwear cannot be expressed solely as a property of the tire since it is the resultant of the interaction of the tire with multivariate environmental conditions.

HS-012 701

**TIRE STRESS AND DEFORMATION FROM COMPOSITE THEORY**

VI N1

H. K. Brewer

See serial citation

\*Pneumatic tires, \*Stress analysis, \*Deformation analysis, \*Tire cords, \*Mathematical analysis, \*Modulus of elasticity,

\*Shear stress, \*Tire materials, \*Tire ply number, \*Strain (mechanics), \*Laminates, \*Structural analysis, \*Tire design, \*Bias tires, \*Bending, \*Aircraft tires, \*Tire load limits, \*Equations of equilibrium, \*Tire mechanics,

The pneumatic tire is treated as a laminated, anisotropic, toroidal shell of revolution possessing bending rigidity. The plies, which are constructed of elastic textile cords embedded in an elastic rubber matrix, are considered homogeneous and orthotropic on a macroscopic scale. The tire shell is considered to deform according to the classical Love hypothesis. The equilibrium, strain-displacement, and laminate constitutive equations governing the tire shell are reduced to a system of six first order, nonlinear, ordinary differential equations with variable coefficients which are solved numerically by a multi-segment forward integration technique. The geometrical nonlinearities due to finite displacements are accounted for by an incrementing process using transient coordinates. The theory is illustrated by a numerical calculation which shows good agreement with actual measurements.

HS-012 702

**MATHEMATICAL PREDICTION OF DYNAMIC TIRE BEHAVIOR**

VI N1

C. F. Zorowski

Presented at Akron Rubber Group Symposium on Tire Mathematics, 23 Apr 1971. flexibility in application. It has the capability of of geometric and cord load parameters designated at any point on the tire carcass. The result is a method of analysis which can be easily applied to study the effects of a variety of tire design and constructional constraints on carcass shape and cord tensions.

See serial citation

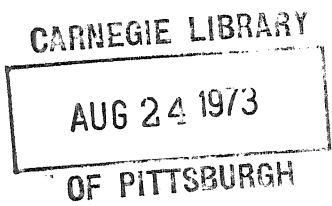
\*Tire mechanics, \*Tire characteristics, \*Structural analysis, \*Mathematical models, \*Finite element method, \*Equations of equilibrium, \*Stress strain characteristics, \*Tire cords, \*Tire design, \*Tire shape, \*Deformation, \*Tire loads, \*Dynamic loads, \*Mechanical properties, \*Stress (mechanics), \*Strain (mechanics),

The difficulties associated with the problem of predicting the mechanical behavior of tires subjected to dynamic loading, and various methods that have been proposed for its treatment are discussed. The application of finite element techniques is emphasized, both with respect to current success and future potential. A detailed analysis of this same problem using classical membrane theory is also presented. Although the model is developed using the same basic considerations employed by earlier investigators, its final formulation provides for greater generality and flexibility in application. It has the capability of defining meridian profiles and cord strains under a condition of inflation and centrifugal loading as a function of geometric and cord load parameters designated at any point on the tire carcass. The result is a method of analysis which can be easily applied to study the effects of a variety of tire design and constructional constraints on carcass shape and cord tensions.

HS-012 703

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